

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
17 May 2001 (17.05.2001)

PCT

(10) International Publication Number  
**WO 01/34497 A1**

(51) International Patent Classification<sup>7</sup>: **B65D 81/05**

29687 (US). **WOFFORD, George, Dean**; 108 Beardon Drive, Duncan, SC 29334 (US).

(21) International Application Number: **PCT/US00/30510**

(22) International Filing Date:  
6 November 2000 (06.11.2000)

(74) Agents: **COHEN, Robert, B. et al.**; Lerner, David, Littenberg, Krumholz & Mentlik, LLP, 600 South Avenue West, Westfield, NJ 07090-1497 (US).

(25) Filing Language: English

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(26) Publication Language: English

(30) Priority Data:  
09/437,411 10 November 1999 (10.11.1999) US

(71) Applicant: **CRYOVAC, INC.** [US/US]; 100 Rogers Bridge Road, Building A, Duncan, SC 29334 (US).

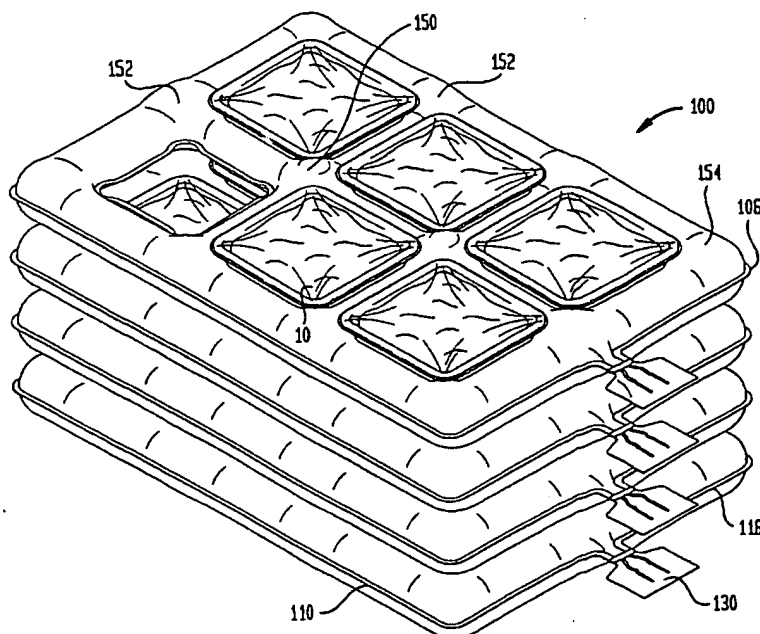
(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

(72) Inventors: **BARMORE, Charles, Rice**; 111 Cumberland Drive, Moore, SC 29369 (US). **CHRISMAN, Kenneth, Paul**; 17 Driftwood Road, Monroe, CT 06468 (US). **COMPTON, Stephen, Floyd**; 107 Brian Drive, Spartanburg, SC 29307 (US). **GARLAND, Steve, B.**; 225 Blockhouse Road, Greenville, SC 29615 (US). **WEINBERG, Alan, S.**; 115 Brook Ann Court, Taylors, SC

Published:  
— With international search report.

[Continued on next page]

(54) Title: **PACKAGING CUSHION AND PACKAGING ASSEMBLIES INCORPORATING SAME**



(57) Abstract: A packaging cushion (100) is disclosed for supporting and protecting objects (10) during shipment. The cushion has upper and lower surfaces and one or more compartments (124) for supporting the objects in positions so that the objects are higher than the lower surfaces of the cushions. The cushions may include upper and lower nodes (150, 152, 154) which increase the separation distance between the objects when the cushions are stacked one on top of another. The cushions may be held in a stack (180) by an outer box (170), or by wrapping the stack of cushions in a protective film (182), eliminating the need for an outer box.

BEST AVAILABLE COPY

WO 01/34497 A1

WO 01/34497 A1



*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

PACKAGING CUSHION AND PACKAGING ASSEMBLIES  
INCORPORATING SAME

Technical Field

5           The present invention relates to packaging materials and, more particularly, to packaging cushions. Still more particularly, the present invention relates to inflatable packaging cushions which may be stacked in layers to protect articles packaged between the layers.

10   Background Art

Protective packaging materials are commonly used to cushion a wide variety of products during shipping. One product which presents particular difficulties is the shipping of meat packaged for retail sale. These meat packages are often prepared  
15   at a processing facility and shipped to multiple retail outlets for sale. In a typical arrangement, portions of meat are packaged in a molded polystyrene tray having a flange projecting laterally from the top edge of the tray. One or more plastic films are heat-sealed to the flange to seal the meat within a protective  
20   atmosphere. A quantity of individual packages are then assembled in an outer box for shipping.

During the shipping of these meat packages, it is critical that the packages do not become damaged in any way. Damage to the tray, film or the tray/film seal may result in  
25   contamination of the packaged product and, for health reasons, require the package and its contents to be discarded. Furthermore, damage to the tray, film or tray/film seal may cause a loss of the protective atmosphere, resulting in rapid spoilage of the product.

30           One arrangement for protecting these packages during shipping utilizes corrugated cardboard dividers to separate multiple layers from one another, as well as to separate individual packages within each layer. In such arrangement, interlocking corrugated cardboard dividers extending in the

length and width directions of an outer box divide each layer of the box into cells, each of which receives one package of meat. A sheet of corrugated cardboard is placed over the first layer, and a second layer of dividers is inserted into the box for receiving another layer of packaged meat. Each layer of dividers is sized to be higher than the meat packages so that an air space is created above the packages in each layer. The corrugated cardboard dividers have good strength in the vertical direction of the box, and therefore satisfactorily protect the meat packages from vertical forces, such as compressive forces caused by stacking the boxes or impact forces resulting from dropping the boxes vertically onto their bottoms. However, these dividers do not adequately protect against forces having components in the horizontal direction. Thus, forces resulting from dropping a box on a side, end or corner, or from sliding a box into a fixed object, cause the trays to slide, whereupon their flanges may contact the dividers or the side of the box, frequently resulting in damage to the package.

There therefore exists a need for improved packaging materials which will enable prepackaged meats and other products to be shipped in quantity without damage. Preferably, such packaging materials will be inexpensive, easy to use and stored in a minimum of space prior to use.

#### Summary of the Invention

The present invention addresses these needs.

One aspect of the present invention provides a packaging cushion for holding at least one tray having a bottom, outwardly-sloping sidewalls and a top edge. The packaging cushion may include one or more ring elements extending generally in a horizontal plane, the ring elements defining one or more openings. The ring elements have top and bottom surfaces and interior side surfaces facing toward the one or more openings. The interior side surfaces of the ring elements are adapted to engage the sidewalls of the tray to support the tray in a

suspended position. Preferably, the interior side surfaces of the ring elements have a substantially cylindrical contour.

The cross-sectional size of all of the ring elements may be about the same. Alternatively, a first group of the ring elements may have a cross-sectional size which is substantially less than the cross-sectional size of a second group of the ring elements. The ring elements in the first group preferably are disposed between adjacent ones of the openings.

The ring elements may define one or more rows of openings, the openings in each row being separated by a first group of the ring elements. Where the ring elements define two or more rows of openings, the openings in one row may be separated from the openings in another row by a second group of ring elements. The second group of ring elements may have a cross-sectional size which is greater than the cross-sectional size of the ring elements in the first group.

In preferred embodiments, the ring elements may be formed from a resilient material. In this regard, the ring elements may include a hollow chamber at least partially filled with a filler material, preferably air. The packaging cushion in accordance with these preferred embodiments may further include a valve member defining an opening for supplying the filler medium to an interior of the chamber.

In highly preferred embodiments, the packaging cushion may further include a plurality of upper nodes projecting upwardly from the ring elements at spaced-apart locations, the upper nodes having top surfaces disposed higher than the top surfaces of the ring elements. In accordance with these embodiments, the interior side surfaces of the ring elements may be adapted to engage the sidewalls of the tray so that the top edge of the tray lies higher than the top surfaces of the ring elements and lower than the top surfaces of the upper nodes. The top surfaces of the upper nodes may be at substantially the same height.

In other highly preferred embodiments, the packaging cushion may further include a plurality of lower nodes projecting downwardly from the ring elements at spaced-apart locations, the lower nodes having bottom surfaces disposed lower than the bottom surfaces of the ring elements. In accordance with these  
5 embodiments, the ring elements may be adapted to engage the sidewalls of the tray so that the bottom of the tray lies lower than the bottom surfaces of the ring elements and higher than the bottom surfaces of the lower nodes. The bottom surfaces of the  
10 lower nodes may be at substantially the same height.

Each of the upper nodes in these embodiments may be substantially aligned over a lower node to define a plurality of node pairs. For each node pair, the top surface of the upper node may be spaced from the bottom surface of the lower node by a  
15 separation distance, the separation distance for each node pair being about the same.

Another aspect of the present invention provides a cushion for holding at least one object. The cushion may include one or more ring elements extending generally in a horizontal  
20 plane and having top and bottom surfaces, the ring elements defining one or more openings. At least one web of material may be positioned in the openings to divide the openings into upper and lower pockets. A plurality of upper nodes may project upwardly from the ring elements at spaced-apart locations, and a  
25 plurality of lower nodes may project downwardly from the ring elements at spaced-apart locations. The upper and lower nodes may be aligned with one another to define a plurality of node pairs. The top surface of the upper node in a node pair may be spaced from the bottom surface of the lower node in the node pair  
30 by a separation distance, which separation distance for each node pair preferably is about the same.

A further aspect of the present invention provides a packaging assembly. The packaging assembly may include a packaging cushion having any of the structural features described

above, and at least one tray having a bottom, outwardly-sloping sidewalls and a top edge. The tray may be assembled in one of the openings in the packaging cushion with the interior side surfaces of the ring elements engaging the sidewalls of the tray to support the tray in a suspended position. Embodiments of the packaging assembly may include a plurality of trays having a bottom, outwardly-sloping sidewalls, a top edge and a flange projecting outwardly from the top edge. The trays may be assembled in cushions in which the ring elements disposed between adjacent openings are smaller in cross-sectional size than the remainder of the ring elements. The trays may be assembled in the openings in these cushions so that the flange of one tray overlaps with the flange of an adjacent tray.

Yet a further aspect of the present invention provides a packaging assembly for holding at least one article. The packaging assembly may include a cushion having one or more ring elements extending generally in a horizontal plane and having top and bottom surfaces, the ring elements defining one or more openings. At least one web of material may be positioned in the openings to divide the openings into upper and lower pockets. At least one object may be assembled in the upper pocket so that the object is supported at a position higher than the bottom surfaces of the ring elements.

In preferred embodiments hereof, a plurality of apertures or a plurality of slits may be formed in the web of material. In highly preferred embodiments, the packaging assembly may further include at least one slit dividing the web of material into first and second portions, and the at least one object may be supported in the upper pocket between these first and second portions.

A still further aspect of the present invention provides a shipping package. Embodiments of the shipping package may include a plurality of cushions, each cushion having upper and lower surfaces and one or more compartments. At least one

object may be assembled in the compartments so that the object is supported at a position higher than the lower surface of the cushion in which it is assembled. The cushions may be arranged one on top of another to form a stack, and an outer container may  
5 be assembled around the stack to hold the stack in assembled relationship. Preferably, the compartments in each of the cushions in the stack confront corresponding compartments in an adjacent cushion to define packaging cells, whereby the object is assembled in the packaging cells.

10 In preferred embodiments of these shipping packages, the outer container may include a box or a securing material wrapped around the stack. A handle may be connected to the securing material. The securing material may include a film material wrapped around the sides of the stack, and preferably  
15 around the top and bottom ends of the stack as well. Preferred film materials are mono- or multi-layer thermoplastic polymer films having a high degree of puncture and abuse resistance. Preferably, such films are shrinkable to form a tight engagement around the stack. A stabilizing layer may be positioned between  
20 the uppermost and/or lowermost cushion in the stack and the securing material.

Other embodiments of the shipping package may include a plurality of cushions, each cushion including one or more ring elements extending generally in a horizontal plane and having top  
25 and bottom surfaces, the ring elements defining one or more compartments. At least one object is assembled in the compartments so that the object is supported at a position higher than the bottom surfaces of the ring elements. The cushions may be arranged one on top of another to form a stack, and an outer  
30 container may be assembled around the stack to hold the stack in assembled relationship. The compartments in each of the cushions may confront corresponding compartments in an adjacent cushion to define packaging cells, whereby the object is assembled in the packaging cells.



Preferred embodiments of these shipping packages may further include at least one web of material positioned in each of the compartments to divide the compartments into upper and lower pockets, wherein the object is supported in the upper  
5 pockets on the webs of material. The webs of material may include a plurality of apertures or slits formed therein. Additionally, each web of material may include at least one slit dividing the web into first and second portions, wherein the object may be supported in the upper pocket between the first and  
10 second portions of the web.

In a highly preferred embodiment hereof, the shipping package may include first and second webs of material positioned in each compartment to divide the compartment into upper and lower pockets, the first web of material confronting the second  
15 web of material to define a space therebetween. One of the first and second webs of material may include a slit providing access to the space, and the object may be assembled in the space.

Still another aspect of the present invention provides methods of packaging at least one tray having a bottom,  
20 outwardly-sloping sidewalls and a top edge. In accordance with these methods, a cushion as described above may be provided, and the tray may be positioned in one of the openings in the cushion to form an assembly in which the interior side surfaces of the ring elements engage the sidewalls of the tray to support the  
25 tray in a suspended position.

In embodiments in which the cushion is provided with a plurality of upper nodes projecting upwardly from the ring elements at spaced-apart locations, the positioning step may include the step of positioning the tray so that the top edge of  
30 the tray in the suspended position lies higher than the top surfaces of the ring elements and lower than the top surfaces of the upper nodes. In embodiments in which the cushion is provided with a plurality of lower nodes projecting downwardly from the ring elements at spaced-apart locations, the positioning step may

include the step of positioning the tray so that the bottom of the tray in the suspended position lies lower than the bottom surfaces of the ring elements and higher than the bottom surfaces of the lower nodes.

5 Preferred methods may further include the step of at least partially surrounding the assembly with an outer container to hold the tray and the cushion in assembled relationship. The surrounding step may include the step of wrapping a film material around the assembly. Highly preferred methods may further  
10 include the step of connecting at least one handle to the film material.

A still further aspect of the present invention provides methods of packaging objects. In accordance with these methods, a plurality of cushions may be provided, each cushion  
15 having upper and lower surfaces and one or more compartments. The objects may be assembled in the compartments so that the objects are supported at positions higher than the lower surfaces of the cushion in which they are assembled. The cushions may be arranged one on top of another to form a stack, and the stack may  
20 be at least partially surrounded with an outer container to hold the stack in assembled relationship. In a preferred arrangement, the cushions may be arranged so that the compartments in each of the cushions confront corresponding compartments in adjacent cushions to define packaging cells, and the object may be  
25 assembled in the packaging cells.

In preferred methods in accordance with this aspect of the invention, the cushions may be provided with a plurality of upper nodes projecting upwardly from the upper surfaces of the cushions at spaced-apart locations, and a plurality of lower  
30 nodes projecting downwardly from the lower surfaces of the cushions at spaced-apart locations. In each cushion, the upper nodes may be substantially aligned over corresponding lower nodes to define a plurality of node pairs. The cushions may be

arranged so that the node pairs in each cushion are substantially aligned with corresponding node pairs in adjacent cushions.

In highly preferred methods, the surrounding step may include the step of wrapping a film material, preferably a mono-  
5 or multi-layer thermoplastic polymer film, around the stack. In addition, a stabilizing layer may be positioned between the uppermost and/or lowermost cushion in the stack and the film material. These methods may also include the step of connecting at least one handle to the film material.

10 Brief Description of the Drawings

A more complete appreciation of the subject matter of the present invention and the various advantages thereof can be realized by reference to the following detailed description in which reference is made to the accompanying drawings in which:

15 FIGURE 1 is a perspective view of the packaging cushions of the present invention arranged in a plurality of layers and showing trays of products assembled in five of the six compartments available in the top layer;

FIGURE 2 is a side elevational view of the layers of  
20 packaging cushions shown in FIGURE 1;

FIGURE 3 is a top plan view of a packaging cushion in accordance with the present invention showing trays of products assembled in three of the six available compartments;

FIGURE 4 is a partial cross-sectional view of the  
25 packaging cushion of FIGURE 3 taken along line 4-4 thereof;

FIGURE 5 is a perspective view showing the packaging cushions of FIGURE 1 assembled in an outer box for shipment;

FIGURE 6 is a perspective view showing the packaging cushions of FIGURE 1 assembled and held in place for shipment by  
30 an outer film wrap;

FIGURE 7 is a perspective view showing the packaging cushions of FIGURE 1 stacked in multiple columns and held in place for shipment by an outer film wrap;

FIGURE 8 is a top plan view of a packaging cushion in accordance with a second embodiment of the present invention showing trays of products assembled in four of the six available compartments;

5           FIGURE 9 is a partial cross-sectional view of the packaging cushion of FIGURE 8 taken along line 9-9 thereof;

FIGURE 10 is a top plan view of a packaging cushion in accordance with a third embodiment of the present invention showing products assembled for shipment therein;

10           FIGURE 11 is a cross-sectional view of the packaging cushion of FIGURE 10 taken along line 11-11 thereof;

FIGURE 12 is a top plan view of a packaging cushion in accordance with a fourth embodiment of the present invention showing a product assembled in one of the four available  
15 compartments;

FIGURE 13 is a cross-sectional view showing multiple packaging cushions of FIGURE 12 in stacked relationship; and

FIGURE 14 is an enlarged partial perspective view showing a pouch for packaging products in the cushion of FIGURE  
20 12.

#### Best Mode of Carrying Out the Invention

Referring to the figures, a packaging cushion 100 in accordance with one embodiment of the present invention is shown  
25 in Figures 1-4. Packaging cushion 100 is intended for use in packaging objects, including meat and other foods, which are held in trays 10 having a bottom 12, outwardly sloping sidewalls 14, and a flange 16 projecting laterally from the top edge of the sidewalls. Flange 16 provides a surface for heat sealing one or  
30 more plastic films or laminates 18 to the tray so as to enclose the packaged object in a protected environment. Trays 10 may include, for example, conventional molded polystyrene trays, trays formed from a thermoformed plastic sheet, and the like.

Packing cushion 100 may consist of two sheets of thermoplastic material 102 and 104 sealed along sealing lines to define one or more chambers having a desired configuration which are then inflated with air or another fill medium. Sheets 102 and 104 may be formed from any number of commercially available mono- or multi-layer thermoplastic polymer films, including films comprised of polyethylene, polyurethane, or poly(ethylene-vinyl acetate). A particularly preferred thermoplastic film is a heat-sealable, gas impermeable film comprised of at least one layer of linear low density polyethylene and a gas barrier layer, such as disclosed in U.S. Patent Application No. 09/438,562, entitled "Heat Sealable Barrier Film for Fluid Fillable Packaging Cushions and Cushions Made Therefrom", which application was filed simultaneously herewith, naming Kelly Ahlgren as inventor. The disclosure of this application is incorporated by reference herein. Briefly, such films include at least one outer layer of a heat-sealable linear low density polyethylene polymer and a gas barrier layer. Additional adhesive layers and/or structural intervening layers may also be included in the laminate. The heat-sealable outer layer is sealable without the use of radio frequency energy, and exhibits good seal strength at elevated temperatures without the need for an ionizing radiation treatment.

To form cushion 100, sheets 102 and 104 are juxtaposed so that their sealable layers confront one another. The sheets are then sealed together in the region of their peripheral edges along weld line 106. The sealing may be performed by conventional techniques, for example, heat sealing. Cushion 100 has an external peripheral edge 108 which essentially describes a rectangle having sides 110 and 112 and ends 114 and 116. Sheets 102 and 104 are also sealed together along weld lines 122 to define a plurality of compartments 124 having a shape which corresponds generally to the shape of the trays 10 to be held therein. Compartments 124 may be formed with a square or

rectangular configuration to accommodate the square or rectangular shape of trays 10 typically used for packaging meats and other perishable foods. However, compartments 124 are not limited to these shapes, and may be formed with round, oval, 5 hexagonal or other shapes as desired. Moreover, the compartments in a single cushion need not all have the same size and shape. Cushion 100 may include only a single compartment 124 where only one product is to be packaged in each layer, or any number of compartments 124 depending upon the size of the cushion and the 10 size of the objects to be held therein. Compartments 124 may be positioned in a symmetrical arrangement, such as the rows and columns depicted in the figures, or in any other positions which will maximize the number of articles which may be packaged within the area defined by a single cushion. Once compartments 124 have 15 been formed, the portions of sheets 102 and 104 interior of weld lines 122 may be removed so that each compartment defines an opening through cushion 100. Alternatively, sheets 102 and 104 may be cut to define compartments 124 prior to being sealed together along weld lines 106 and 122. The material defining 20 compartments 124 need not be removed entirely. Rather, the material may be slit in an "x" pattern between the opposite diagonal corners of the compartments so that it can be pivoted away along weld lines 122 to form the openings through the cushion.

25 Cushion 100 may be provided with a single inflation valve 130 positioned at any one of a number of locations along peripheral edge 108. Inflation valve 130 may be formed from portions of thermoplastic sheets 102 and 104 projecting outwardly from peripheral edge 108 and sealed together along spaced weld 30 lines 132 and 134 so as to form an inlet passage 136 for an inflation nozzle. After cushion 100 has been inflated, passage 136 may be hermetically sealed, as at weld line 138, using conventional techniques, thereby sealing cushion 100 in the

inflated condition. Alternatively, valve 130 may be one of the self-sealing types of valves which are known in the art.

As it exits the manufacturing process, cushion 100 is in a flat, deflated state. In this condition, cushion 100 occupies a small volume, so that a plurality of the cushions may be shipped to an end user and stored in a minimum of space. The end user may then inflate cushion 100 with a filler medium in a known fashion, and seal passage 136 to maintain the cushion in an inflated state. Although a preferred filler medium for inflating cushion 100 is air, any gas providing particularly desirable properties may be used. Furthermore, rather than air or another gas, cushion 100 may be filled with a liquid, gel, expandable foam or other substance in order to take advantage of the cushioning and shock dampening properties of these materials. The greater weight of these filler materials, however, makes them less desirable for shipping purposes.

As cushion 100 is inflated, sheets 102 and 104 bulge away from one another until the cushion has achieved its inflated shape. Continued inflation will not significantly alter the shape, but will impact the resiliency and overall flexibility of the cushion. Upon inflation, the regions of cushion 100 between adjacent compartments 124 form legs 140. Similarly, the outer periphery of cushion 100 forms legs 142 in the regions adjacent each compartment 124. When inflated, legs 140 and 142 preferably have a generally cylindrical cross-section. The distance between the weld lines 122 in adjacent compartments 124 determines the diameter of legs 140 in the inflated condition. Similarly, the distance between the weld lines 122 and the portions of weld line 106 opposed thereto determines the diameter of legs 142. Thus, if these weld lines are formed so that the distance between them is about the same, legs 140 and 142 would have similar diameters. As will be explained below, legs 140 and 142 do not have to be similar in diameter and, in fact, may purposefully be made with significantly different diameters.

Legs 140 and 142 interconnect with one another to form continuous rings extending generally in a horizontal plane and defining compartments 124. As used herein, the term "horizontal plane" refers to the plane defined by the length and width directions of cushion 100 (i.e., the plane of the page in Figure 3). As a result of the geometry of compartments 124 and their arrangement in cushion 100, there may be a greater free expanse of materials 102 and 104 at the points where two or more legs intersect with one another than there is between the weld lines forming the legs. Hence, upon inflation of cushion 100, these points of intersection expand by a greater amount than legs 140 and 142, thereby forming bulbous regions or "nodes" which project higher than legs 140 and 142 on one face of cushion 100 and lower than legs 140 and 142 on the opposite face of cushion 100. These nodes may interfere with the flange 16 on tray 10 as the tray is inserted into compartment 124, preventing the tray from being properly seated in the compartment. By controlling the amount of free expanse of materials 102 and 104 at each node, however, the shape of the node may be altered so as to avoid any interference with the trays. Furthermore, controlling the amount of free expanse of materials 102 and 104 at each node permits adjustment of the overall thickness of cushion 100 at the nodes.

In a symmetrical arrangement in which compartments 124 are spaced substantially equidistant from one another and from the peripheral edge 108 of cushion 100, the greatest free expanse of materials 102 and 104 ordinarily would be at nodes 150, each of which defines the point of intersection of four legs 140. Without any adjustment of the free expanse of materials 102 and 104 in this region, nodes 150 would define the area in which the thickness of cushion 100 is greatest. The second greatest free expanse of materials 102 and 104 would be at the positions where two legs 142 intersect with a third leg 140, defining nodes 152; and the third greatest free expanse of materials 102 and 104 would be at nodes 154, defined by the intersection of two legs



142. Without adjustment of the free expanse of materials 102 and 104 in these regions, nodes 152 would define the second thickest areas of cushion 100, and nodes 154 would define the third thickest areas of cushion 100. Nodes 150, 152 and 154 all would have thicknesses greater than the thicknesses of legs 140 and 142.

Nodes 150, 152 and 154 act to separate the legs 140 and 142 of one cushion 100 from the legs 140 and 142 in a next adjacent cushion 100 when the cushions are stacked on top of one another. More importantly, nodes 150, 152 and 154 increase the separation distance between the trays 10 assembled in one layer and the trays 10 assembled in a next adjacent layer, and separate the legs 140 and 142 in one cushion 100 from the flanges 16 of the trays assembled in an underlying cushion. Without detracting from this separating function, it is desirable to have nodes 150, 152 and 154 all at about the same height on both the top and bottom surfaces of cushion 100 to improve the stability of the cushions when they are stacked in layers. As noted above, the height of the nodes is dependent upon the amount of free expanse of materials 102 and 104 available in a particular region. The free expanse of these materials, in turn, is related to the distance by which compartments 124 are separated from one another and from the peripheral edge 108 of the cushion, i.e., the diameters of legs 140 and 142. Thus, as the diameters of legs 140 and 142 increase, the free expanse of materials 102 and 104 at their points of intersection will increase, as will the heights of the nodes at these points of intersection. Therefore, one mechanism for controlling the height of a node is to adjust the diameter of the adjacent legs 140 and/or 142.

Referring to Figure 3, it can be seen that the sides and ends of compartments 124 are not joined by smooth regularly curved corners. Rather, weld lines 122 define outwardly projecting dimples 160 at the corners of each compartment. Dimples 160 provide clearance for trays 10 to be inserted in

compartments 124 without the flanges 16 of the trays contacting the nodes. The formation of these dimples also reduces the free expanse of materials 102 and 104 in the regions adjacent the corners of the compartments, thereby reducing the height of the nodes in those regions. The bigger the dimple formed at the corner of a compartment, the greater the reduction will be in the height of the adjacent node. Hence, once the diameters of legs 140 and 142 have been selected to provide an acceptable amount of separation between adjacent trays 10 in cushion 100 and to provide nodes 150, 152 and 154 of sufficient height, dimples 160 of an appropriate size may be formed to reduce the height of the nodes to a desired level.

Dimples 160 may all be formed with the same size, or may be formed in two or more different sizes depending upon the amount by which the height of a particular node is to be reduced, as well as the number of dimples contributing to that reduction. As noted, nodes 150 are highest on the top surface of cushion 100 and lowest on the bottom surface of cushion 100, and therefore require the greatest amount of adjustment. Moreover, it can be seen that the adjustment of each node 150 may be effected by the formation of four dimples 160a, each at a corner of the four compartments 124 adjacent the node, all of which dimples may be of about the same size. Nodes 152 require the next amount of adjustment, but each has only two dimples 160b available to effect that adjustment. Consequently, dimples 160b may be larger in size than dimples 160a, and all of dimples 160b may be about the same size as one another. Lastly, nodes 154 require the least amount of adjustment which may be effected through a single dimple 160c, all of which dimples may be about equal in size. Because cushion 100 is formed from a resilient material, small variations in the overall height of nodes 150, 152 and 154 ordinarily will be accommodated by the compression of the nodes as the cushions are stacked one on top of another. Thus, it is not critical that the nodes have precisely the same height.

Furthermore, it will be appreciated that dimples 160 need not be formed at a corner of a compartment 124, but may be formed at any position adjacent a node such that the formation of the dimple will reduce the free expanse of materials 102 and 104 forming the node and, hence, will reduce the height of the node. Preferably, dimples 160 are formed along weld lines 122 to simplify the manufacturing process.

Once cushion 100 has been inflated, it may be used to hold one or more trays 10 in a suspended position. As used herein, the term "suspended position" refers to positions in which the trays or other objects are supported in one compartment so that they are spaced from the trays or other objects in other compartments and spaced from any outer containers. Figure 4 is a cross-sectional view showing two trays 10 inserted in adjacent compartments 124 of a cushion 100. Each of compartments 124 is sized so that, when a tray is assembled therein, all of the legs 140 and 142 forming the compartment contact the tray at about the midpoint of its sidewalls 14. That is, tray 10 is inserted into a compartment 124 until it nests therein with its sidewalls 14 contacting and supported at tangent points on legs 140 and 142. In this supported position, the bottoms 12 of the trays lie higher than the lowermost surfaces of downwardly projecting nodes 150, 152 and 154. This arrangement spaces the bottoms 12 of trays 10 both from the bottom of the outer box or other packaging structure on which cushions 100 are stacked, and from the film 18 sealing the trays in any underlying cushions. This position also may support the flanges 16 of the trays at a position higher than the upper surfaces of legs 140 and 142, but lower than the upper surfaces of nodes 150, 152 and 154. Once the compartments 124 of a cushion 100 have been filled with trays 10 as desired, a second cushion 100 may be positioned over the first cushion so that the compartments and the nodes in the second cushion are in alignment in the vertical direction with the corresponding compartments and nodes in the first cushion, as shown in Figure 2. As used

herein, the term "vertical direction" refers to the direction perpendicular to the length and width directions of cushion 100. Trays 10 may then be assembled in the compartments 124 of the second cushion, and the process repeated until the desired number  
5 of cushions 100 have been stacked on top of one another.

When trays 10 are nested within compartments 124, the trays are amply protected from damage during shipment. Lateral or side-to-side protection is provided by legs 140 which keep the trays 10 separated from one another by a safe distance, and legs  
10 142 which keep the trays spaced from the sides of an outer shipping container. Protection in the top-to-bottom or vertical direction is provided in two ways. Firstly, as noted above, the sidewalls 14 of trays 10 are supported at tangent points on legs 140 and 142. In this nested position, trays 10 are suspended  
15 with their bottoms 12 lying higher than the lowermost surfaces of downwardly projecting nodes 150, 152 and 154. As a cushion/tray assembly is dropped, the trays exert a downward force on the cushion. This force causes legs 140 and 142 to deform so that the sidewalls 14 of the trays engage an increasingly larger  
20 surface area of the legs. The deformation of the legs absorbs a portion of the impact force, hastening the deceleration of the trays and preventing the bottoms of the trays from extending beyond the lowermost surfaces of nodes 150, 152 and 154. In addition, when cushions 100 are stacked on top of one another,  
25 the downwardly projecting nodes 150, 152 and 154 on one cushion rest upon the nodes projecting upwardly from the underlying cushion. This arrangement creates an increased separation distance between the trays in the one cushion and the trays in the underlying cushion. When the assembly is dropped, each  
30 cushion/tray layer will exert a force on the underlying layer, causing the nodes between the layers to compress. This compression also absorbs a portion of the impact force, further hastening the deceleration of the trays and preventing the trays in one layer from contacting the trays in the underlying layer.

In order to ship trays 10 and their contents to another location, cushions 100 may be stacked one on top of another in an outer receptacle, such as a conventional or more highly reinforced corrugated cardboard box 170, as shown in Figure 5.

5 In such event, the outer peripheries of cushions 100 preferably are adapted to the shape and dimensions of the outer box so that the cushions fit snugly within the box with little or no lateral movement. In this regard, inflation valves 130 serve as a convenient grip facilitating the handling of cushions 100 as they

10 are loaded into and unloaded from box 170. It will be appreciated that additional tabs (not shown) may be formed on the peripheral edges 108 of the cushions to provide additional grips for handling. These additional tabs need not be in the form of inflation valves. In an alternate embodiment, cushions 100 may

15 include one or more handles (not shown) formed on the peripheral edges 108 of the cushions. The handles may be formed by attaching, such as by heat sealing, the ends of a separate plastic strap to the cushion to provide a handle into which the fingers of a hand may be inserted for grasping. Alternatively,

20 the handles may be formed integrally with the cushion, such as by heat sealing the sheets of thermoplastic material in one or more locations adjacent the peripheral edges of the cushion in an elongated pattern, and then slitting or removing the material within the patterns to form apertures for the fingers of a hand.

25 Once the box 170 has been filled with the desired number of cushions 100 in stacked relationship, the box may be sealed in a known fashion and shipped.

As a result of the structural integrity of cushions 100 and the way in which they securely support trays 10, cushions 100

30 may be shipped in stacked relationship without the use of an outer box. That is, referring to Figure 6, cushions 100 may be arranged on top of one another to form a stack 180. Stack 180 may be held in this assembled relationship by one or more passes of a high strength film, a shrink wrap film, a banding material,

an adhesive tape or any other material useful for this purpose. Preferred are film materials which may be wrapped around stack 180 to completely enclose same, and which have sufficient strength and toughness to hold the cushions in assembled relationship. Particularly preferred is a polymer film 182, such as the high abuse shrink wrap film described in commonly owned U.S. Patent No. 5,846,620, the disclosure of which is hereby incorporated by reference herein. Such films may include a first layer selected from the group consisting of linear low density polyethylene, high density polyethylene, homogeneous ethylene/alpha-olefin copolymer, polycarbonate, polyester homopolymer, polyamide, ethylene/acid copolymer, ethylene/ester copolymer, ethylene/vinyl acetate copolymer, ionomer, ethylene/carbon monoxide, very low density polyethylene, low density polyethylene, polyolefin, ethylene/propylene copolymer, ethylene/norbornene copolymer, and ethylene/styrene copolymer. The first layer may be sealed to itself or to a second layer including at least one member selected from the group consisting of linear low density polyethylene, high density polyethylene, homogeneous ethylene/alpha-olefin copolymer, polycarbonate, polyester, polyamide, ethylene/acid copolymer, ethylene/ester copolymer, ethylene/vinyl acetate copolymer, ionomer, ethylene/carbon monoxide, very low density polyethylene, low density polyethylene, polyolefin, ethylene/propylene copolymer, ethylene/propylene/diene terpolymer, ethylene/norbornene copolymer, and ethylene/styrene copolymer. Film 182 may be transparent if it is desirable to have the packaged product visible through the film, or may be pigmented to render the overwrapped assembly opaque.

Film 182 may be wrapped around the stack of cushions 100 from the bottom, up one side, across the top and then down the opposite side of the stack. The edges of the film may then be joined together, such as by heat sealing to form seam 188, to completely enclose the stack within the film. Prior to wrapping

film 182 around the stack, a stabilizing sheet 184 may be positioned at the top and/or bottom of stack 180. Stabilizing sheet 184 attenuates the undulating surfaces of the cushions at the top and bottom of the stack, thereby providing a more stable surface for stacking overwrapped groups of cushions on top of one another. Stabilizing sheet 184 may be formed from a wide variety of rigid or flexible materials, including high density polyethylene, corrugated cardboard and fiberboard. A particularly preferred material is a recycled plastic sheet having a thickness of 30-100 mils.

During the step of sealing film 182 around the stack, strips of plastic or other material 186 may be inserted into seam 188 and held in place by the sealing operation. The strips of material may serve as handles for stacking, handling and carrying the overwrapped cushions. Once the overwrap process has been completed, the entire package may be subjected to a conventional heat shrink process to shrink film 182 and tighten it around cushions 100. When packaged in this manner, cushions 100 may be shipped without the use of a separate outer container.

In an alternate arrangement, film 182 may be wrapped around the outer periphery of the stack and stabilizing sheets 184 so that film 182 covers only the peripheral edges of stabilizing sheets 184 with the remainder of stabilizing sheets 184 remaining exposed. In this arrangement, stabilizing sheet 184 protects the top layer of trays 10 in the stack from loss or damage during shipment, and is therefore preferably formed from a strong, moisture resistant material.

In another arrangement, cushions 100 may be stacked in one or more columns on a pallet or other support structure, with the columns held in place for shipment by an overwrap 187 of a film, a banding material, an adhesive tape or other useful material. A system in which cushions 100 are arranged on a pallet 190 in four columns 192, 194, 196 and 198 is shown in Figure 7. Each column may be individually wrapped with an outer

film 182, with stabilizing sheets 184 at the top and/or bottom of the column as described above in connection with stacks 180. The overwrapped columns may then be placed on pallet 190 and wrapped with overwrap 187. Overwrap 187 may be the same high abuse shrink wrap film as film 182. Alternatively, columns 192, 194, 196 and 198 may be assembled on pallet 190 without being individually overwrapped. The entire assembly may then be wrapped with overwrap 187.

A second embodiment of a cushion 200 in accordance with the present invention is shown in Figures 8 and 9. Cushion 200 is configured to enable the trays 10 assembled therein to be partially overlapped with one another so that a higher density of trays 10 can be packaged in a given volume. Cushion 200 is similar in construction to cushion 100 described above. However, rather than all of the legs in the cushion being similar in diameter, the legs 241 disposed between compartments 124 and extending in the width direction of cushion 200 are substantially smaller in diameter than both the legs 142 positioned along the periphery of the cushion and the legs 140 disposed between the compartments and extending in the length direction of the cushion.

The intersection of two legs 241 with two legs 140 defines nodes 251; the intersection of one leg 241 with two legs 142 defines nodes 253; the intersection of one leg 140 with two legs 142 defines nodes 255; and the intersection of two legs 142 defines nodes 257. Since the diameter of legs 241 is smaller than the diameter of legs 140 in cushion 100 described above, the free expanse of materials 102 and 104 at nodes 251 is less than the free expanse of these materials at the corresponding nodes 150 in cushion 100 (assuming the diameter of legs 140 is the same in cushions 100 and 200). Hence, without any adjustment in their height, nodes 251 would be lower in height than unadjusted nodes 150. A further reduction in the height of nodes 251 occurs when dimples 260a are formed at the corners of compartments 124



adjacent the nodes for the purpose of providing clearance so that the flanges 16 of trays 10 do not contact the nodes.

As with cushion 100, a lower free expanse of materials 102 and 104 is available at the positions of nodes 253 than is available at the positions of nodes 251 such that, following the formation of dimples 260b, nodes 253 may be lower in height than nodes 251. Further reducing the height of nodes 251 to make the height of all the nodes about equal may have a detrimental impact on the ability of cushions 200 to keep the trays 10 in one layer separated from the trays in the next adjacent layer, particularly as cushions 200 are deformed as the shipping container is dropped or otherwise mishandled. Therefore, to make the height of nodes 251 and 253 about the same, the height of node 253 may be increased. This may be accomplished by forming bumps 261 which project outwardly from the sides 110 and 112 of cushion 200 alongside nodes 253. Bumps 261 increase the free expanse of materials 102 and 104 available at the positions of nodes 253. Thus, by controlling the size of bumps 261, the height of nodes 253 may be increased as desired. Lastly, the size of dimples 260c and 260d may be adjusted to adjust the height of their corresponding nodes 255 and 257.

FIGURE 9 is a cross-sectional view showing three trays 10 inserted in adjacent compartments 124 of a cushion 200. Each of compartments 124 is sized so that, when a tray is assembled therein, all of the legs 140, 142 and 241 forming the compartment contact the tray at about the midpoint of its sidewalls 14. However, because legs 241 of cushions 200 are smaller in diameter than legs 140 of cushions 100, trays 10 in cushion 200 will be positioned closer to one another in the length direction of the cushion, and, in fact, may be positioned so that the flange 16 of the tray 10 in one compartment overlaps with the flange of the tray in an adjacent compartment. This arrangement enables cushion 200 to hold the same number of trays 10 as cushion 100,

but in a smaller area. That is, cushion 200 provides a higher packaging density than cushion 100.

It will be appreciated that, since legs 140, 142 and 241 lie generally in the same horizontal plane, the axes of legs 140, 142 and 241 lie in substantially the same plane. Therefore, assuming all of compartments 124 have about the same dimensions, trays 10 will all rest at about the same height. To alleviate any damage which may be caused by the overlapping flanges 16, the central compartments 124 may be formed with slightly smaller length and width dimensions so that legs 140, 142 and 241 contact the trays 10 suspended in these compartments at lower positions on their sidewalls 14, thus supporting these trays at a slightly higher elevation than the trays are supported in the outer compartments 124. In any event, the bottoms 12 of trays 10 in their nested positions preferably lie higher than the lowermost surfaces of downwardly projecting nodes 251, 253, 255 and 257, spacing the trays in one cushion 200 from the trays 10 in an underlying cushion. In addition, the flanges 16 of the trays in their suspended positions preferably lie higher than the upper surfaces of legs 140, 142 and 241, but lower than the upper surfaces of nodes 251, 253, 255 and 257. Once the compartments 124 of cushions 200 have been filled with trays 10 as desired, cushions 200 may be packaged and shipped in the same manner as cushions 100 described above.

Cushions 200 act in a manner similar to cushions 100 to protect the trays 10 during shipment. Thus, legs 140 and 241 keep the sidewalls 14 of trays 10 separated from one another, and legs 142 keep trays 10 separated from the sides of an outer shipping container, thereby providing side-to-side protection to the trays. Protection in the vertical direction is provided by the deformation of legs 140, 142 and 241. As a cushion/tray assembly is dropped, the downward force exerted by trays 10 will deform legs 140, 142 and 241 by similar amounts, thereby maintaining approximately the same separation distance between

the flanges 16 of the trays 10 nested in the center compartments 124 and the flanges 16 of the trays nested in the outer compartments 124. Additional protection in the vertical direction is supplied by the compression of nodes 251, 253, 255 and 257. Cushions 200 may be stacked on top of one another and shipped in the same fashion as described above in connection with cushions 100. That is, the cushions may be placed in an outer box and shipped, or may be wrapped with a film 182 or other material and shipped without the use of an outer box.

10           A third embodiment of a cushion 300 in accordance with the present invention is shown in Figures 10-11. Cushion 300 has a round configuration which may be desirable for the shipment of items packaged in trays 20 having a circular shape. Trays 20 have a bottom 312 and an outwardly sloping sidewall 314, but  
15           differ from trays 10 described above in that they preferably do not include a laterally projecting flange at the top edge of the sidewall.

Cushion 300 may be formed in the same manner as cushions 100 and 200 described above. That is, cushion 300 may  
20           consist of two sheets of thermoplastic material 102 and 104 sealed together in the region of their peripheral edges along weld line 306, and sealed together inwardly thereof along weld line 322 to define a single circular compartment 324. Following the formation of compartment 324, the thermoplastic material  
25           interior of weld line 322 may be removed so that compartment 324 defines an opening through cushion 300. In an alternate procedure, sheets 102 and 104 may be cut to define compartment 324 prior to being sealed together along weld lines 306 and 322. An inflation valve 330 may be formed along weld line 306 for  
30           filling the cushion with a filler medium, such as air.

In its inflated condition, cushion 300 forms a continuous ring 340 having a generally toroidal shape which defines compartment 324. One feature differentiating cushion 300 from cushions 100 and 200 described above is that cushion 300

does not form bulbous regions or nodes when inflated. That is, since the distance between weld lines 306 and 322 is substantially constant around the entirety of cushion 300, there are no regions which include a greater free expanse of materials  
5 102 and 104, such that ring 340 has a substantially uniform diameter.

Once inflated, cushion 300 may be used to hold tray 20 in a suspended position with the sidewall 314 of the tray supported along a tangent line on ring 340. In this supported or  
10 nested position, the bottom 312 of tray 20 may lie higher than the lowermost surface of ring 340 and the upper edge of tray 20 may lie lower than the uppermost surface of ring 340. In such arrangement, the tray 20 supported by one cushion 300 will be spaced from the tray 20 supported by a next adjacent cushion when  
15 the cushions are stacked on top of one another, as can be seen in Figure 11.

Cushions 300 may be stacked one on top of the other in any desired number of layers. The stacked layers may be assembled in an outer box or tube (not shown) for shipment, or,  
20 alternatively, a single stack or multiple stacks may be wrapped with a film 182 or other material for shipment as described above.

Although packaging cushions 100, 200 and 300 are all described above as being in the form of inflatable chambers, it  
25 will be appreciated that these cushions may be formed from any material having sufficient strength to support trays 10 or 20 along their sidewalls while absorbing impact forces so as to prevent the trays from becoming damaged. Such materials may absorb these impact forces by collapsing or deforming while  
30 preventing the trays from impacting one another or the outer container. Examples of such materials include polystyrene, expanded resinous foams and like materials which may be molded or otherwise formed to include the features of cushions 100, 200 or 300 described above. Preferred materials, however, are resilient

and absorb such forces by resiliently deforming, again while preventing the trays from impacting one another or the outer container. Such resilient materials may include, for example, plastic foam materials, foam rubbers and the like, molded or otherwise formed to include the features of the cushions.

Although the foregoing describes the use of cushions 100, 200 and 300 to support trays 10 or 20 having outwardly sloping sidewalls, these cushions also may be used to support trays having sidewalls which are oriented in the vertical direction and parallel to one another. Trays having an upper flange, such as flange 16 on trays 10, may be supported by the engagement of the flange with the upper surface of the cushion. The flange may be reinforced where needed so as to have sufficient strength to support the trays without being damaged. Where the trays do not have flanges, or where the flanges have insufficient strength to support the trays, the compartments in the cushions may be sufficiently small in size to support the trays by frictional engagement. In still other arrangements, the trays may be molded so as to define support surfaces (other than upper flanges) protruding inwardly or outwardly from the sidewalls of the tray. For example, inwardly projecting channels may extend partially up the sidewalls of the tray, the ends of the channels defining inwardly protruding ledges. The compartments in the cushions may be formed with inwardly facing projections at locations corresponding to the support surfaces on the trays, whereupon the projections in the compartments of the cushions will engage the support surfaces on the trays to support the trays in suspended positions.

A still further embodiment of a cushion 400 in accordance with the present invention is shown in Figures 12 and 13. Cushions 400 may be used to package and ship a large variety of objects, including objects held in molded trays, such as trays 10 and 20, objects packaged in other materials, such as bags, pouches, films and boxes, and objects not having any individual

packaging. Cushions 400 are similar in construction to cushions 100 described above, and may be formed from thermoplastic materials 402 and 404 which may be the same as materials 102 and 104. Although cushions 400 are shown to include only four compartments 424, they may include a single compartment or any number of compartments depending on the size of the cushion and the size of the objects to be held therein. Cushions 400 differ significantly from cushions 100 in that in cushions 400, the portions of materials 402 and 404 interior of weld lines 422 are not removed or slit from corner to corner, but rather are left intact after compartments 424 have been formed. These material layers form webs 425 dividing each compartment 424 into an upper pocket 427 and a lower pocket 429. As described below, when two cushions 400 are stacked on top of one another, pockets 427 and 429 cooperate with one another to surround the objects being shipped and to protect them from damage.

Referring to Figure 13, with cushion 400 inflated, objects O to be packaged may be placed in one or more upper pockets 427 as desired. When positioned in a pocket, the object O rests upon the web 425 forming the floor of the pocket. Compartments 424, and thus pockets 427 and 429, may be sized so that the objects O assembled therein occupy substantially the entire surface area of the pocket, leaving little room for lateral movement of the object within the pocket. Where an object is substantially smaller than the surface area of a pocket, a padding material, fill material or other dunnage may be inserted in the pocket around the object or wrapped around the object to occupy a substantial portion of the void space.

After objects O have been placed in the pockets 427 of one cushion 400, a second cushion 400 may be positioned over the first cushion so that the lower pockets 429 in the second cushion are positioned over the objects in the first cushion. In this manner, each lower pocket 429 in the second cushion cooperates with a confronting upper pocket 427 in the first cushion to

define an enclosed cell 431 which entirely surrounds object O. It will be appreciated that the height of cells 431 between the webs 425 in the second cushion and the webs 425 in the first cushion is dependent upon the diameter of legs 440 and 442 defining compartments 424, as well as the height of any nodes formed at the intersections of legs 440 and 442. Hence, by controlling the diameter of legs 440 and 442 and the formation of nodes, cells 431 can be formed with a height which is similar to the height of the objects O being packaged therein.

10           As with cushions 100, the height of any nodes formed at the intersections of legs 440 and 442 may be controlled by the formation of dimples 460 at the corners of compartments 424. Preferably, dimples 460 are sized so that cushions 400 have nodes which are very small in height or, more preferably, no nodes at all. That is, to optimize the protection of objects O, it is desirable to minimize the height of the nodes so as to minimize any gaps between confronting cushions which could enable the objects to escape from the cells 431 in which they are held.

20           The presence of dimples 460 also permits larger rectangular objects to be held in compartments 424 without increasing the length and width of the compartments. In this regard, dimples 460 provide relief at the corners of the compartments to accommodate the corners of rectangular objects.

25           The shock absorbing and protective performance of cushions 400 may be improved by forming slits 461 in webs 425 at the corners of compartments 424, preferably within the area of dimples 460. Since each web 425 is constrained in two directions at the corners of the compartments, the stress in the webs is greatest at these points. By forming slits 461, the stress in web 425 is more uniformly distributed, and the web is able to absorb a greater degree of shock without failure. Where desired, web 425 may be made more yielding, such as by forming a plurality of apertures 463 in the web or a plurality of slits 465 in the

30

web in the length, width or diagonal directions of the compartment.

Where the height of cells 431 is similar to the height of objects O, there will be little, if any, deflection of webs 425 when two cushions 400 are assembled around the object, depending, of course, on the weight of the objects. Alternatively, the diameters of legs 440 and 442 may be sized so that the height of cells 431 is smaller than the height of objects O by a selected amount. In this scenario, when two cushions 400 are assembled around an object O, the webs 425 therein will be deflected away from one another, such that the tension in the webs will hold the object firmly therebetween.

In certain situations, the objects O being packaged in cells 431 may be so thin that it would be impractical to make the height of the cells similar to or smaller than the height of the objects. In those situations, there ordinarily would be a relatively large void space between the object O and the web 425 in the overlying pocket 429. This void space may be filled with conventional dunnage to prevent the object O from bouncing around within the cell. Alternatively, the webs 425 in the lower cushion 400 may be formed with one or more slits which may be used to hold the object O in place. Slits 461, for example, may be used for this purpose. The corners of object O may be inserted into slits 461, whereupon the object will be held against the web. In a variant of this arrangement, a pair of parallel slits 467 may form a central strip 469 in the length, width or a diagonal direction in compartments 424. The object O to be packaged may be inserted and held in place between web 425 and strip 469. In a still further arrangement, a single slit may be formed in one of the layers of materials 402 and 404 forming a web 425, but not in the other layer. For example, a slit 471 may be formed in material layer 402, but not in material layer 404. Slit 471 would provide access to the pouch 473 formed in web 425



between layers 402 and 404. Object O may be inserted through slit 471 to be held in pouch 473 during shipping.

Ordinarily, two cushions 400 would be used to package only a single layer of objects O within an outer box or other container. Where it is desired to package a second layer of objects O in the same container, such objects would ordinarily be packaged in the cells 431 defined between third and fourth cushions 400 stacked above the first and second cushions. Additional cushions may be added to the stack and filled with objects O in the same pattern. Typically, no objects O would be packaged in the cells 431 defined between alternating cushions, such as the second and third cushions, in those cases in which the objects occupy substantially the entire height of the cells. However, where the objects being packaged have a relatively low height relative to the height of cells 431 such that there is a large void space between the objects and the webs 425 in the overlying pockets 429, the objects may be packaged in the cells defined between each adjacent pair of cushions, i.e., between the first and second cushions, the second and third cushions, the third and fourth cushions, etc.

When objects O are packaged between two cushions 400, the cushions isolate the objects within cells 431 and protect them from damage. Thus, legs 440 and 442 define the sides of cells 431, separating the objects from one another and from the sides of an outer shipping container, providing side-to-side protection during shipping. Protection in the top-to-bottom direction is provided both by legs 440 and 442 and by webs 425. If the shipping container is dropped, legs 440 and 442 will compress, absorbing a portion of the impact force. In addition, webs 425 may stretch, absorbing a further component of the impact force. The combined action of the legs and the webs retains the packaged objects in a suspended position within the shipping container and prevents impact damage. Cushions 400 may be stacked on top of one another and shipped in the same way as the

previously described cushions. In other words, cushions 400 may be placed in a conventional outer box or other container and shipped, or they may be wrapped with a film 182 or other material and shipped without the use of an outer box.

5           As with cushions 100, 200 and 300 described above, cushion 400 may be formed from any material having sufficient strength to support objects O within cells 431 while absorbing the forces which may be exerted thereon during shipping. Suitable materials may include, for example, polystyrene,  
10   expanded resinous foam and like materials, which absorb impact forces by collapsing or deforming while preventing the objects from impacting one another or the outer container. These materials may be molded or otherwise formed to include the features of cushion 400 described above. Preferred materials,  
15   however, are resilient and absorb such forces by resiliently deforming by a small amount, again while preventing the objects from impacting one another or the outer container. Examples of such resilient materials include plastic foam materials, foam rubbers and the like.

20           Although the invention herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the  
25   illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.

#### Industrial Applicability

30           The packaging structures of the present invention hold objects safely during shipment and cushion them from mechanical shock resulting from mishandling of the package.

## WHAT IS CLAIMED IS:

1. A packaging cushion for holding at least one tray having a bottom, outwardly-sloping sidewalls and a top edge, said  
5 cushion comprising

one or more ring elements extending generally in a horizontal plane, said ring elements defining one or more openings, said ring elements having top and bottom surfaces and having interior side surfaces facing toward said one or more  
10 openings, said interior side surfaces of said ring elements being adapted to engage the sidewalls of the at least one tray to support the tray in a suspended position.

2. The packaging cushion as claimed in claim 1, further comprising a plurality of upper nodes projecting upwardly  
15 from said ring elements at spaced-apart locations, said upper nodes having top surfaces disposed higher than said top surfaces of said ring elements, said interior side surfaces of said ring elements being adapted to engage the sidewalls of the at least one tray so that the top edge of the tray lies higher than said  
20 top surfaces of said ring elements and lower than said top surfaces of said upper nodes.

3. The packaging cushion as claimed in claim 2, wherein said top surfaces of said upper nodes are at substantially the same height.

25 4. The packaging cushion as claimed in claim 2, further comprising a plurality of lower nodes projecting downwardly from said ring elements at spaced-apart locations, said lower nodes having bottom surfaces disposed lower than said bottom surfaces of said ring elements, said ring elements being  
30 adapted to engage the sidewalls of the at least one tray so that the bottom of the tray lies lower than said bottom surfaces of said ring elements and higher than said bottom surfaces of said lower nodes.

5. The packaging cushion as claimed in claim 4, wherein said bottom surfaces of said lower nodes are at substantially the same height.

6. The packaging cushion as claimed in claim 4,  
5 wherein each one of said upper nodes is substantially aligned over one of said lower nodes to define a plurality of node pairs.

7. The packaging cushion as claimed in claim 6, wherein, for each one of said node pairs, said top surface of said upper node is spaced from said bottom surface of said lower  
10 node by a separation distance, said separation distance for each one of said node pairs being about the same.

8. The packaging cushion as claimed in claim 1, wherein said interior side surfaces of said ring elements have a substantially cylindrical contour.

15 9. The packaging cushion as claimed in claim 1, wherein said ring elements have a cross-sectional size, said cross-sectional size of each one of said ring elements being about the same.

10. The packaging cushion as claimed in claim 1,  
20 wherein said ring elements have a cross-sectional size, said cross-sectional size of a first group of said ring elements being substantially less than said cross-sectional size of a second group of said ring elements.

11. The packaging cushion as claimed in claim 10,  
25 wherein said first group of ring elements are disposed between adjacent ones of said openings.

12. The packaging cushion as claimed in claim 1, wherein said ring elements define one or more rows of said openings, said openings in each of said rows being separated by a  
30 first group of said ring elements.

13. The packaging cushion as claimed in claim 12, wherein said ring elements define two or more rows of said openings, said openings in one of said rows being separated from said openings in another one of said rows by a second group of

said ring elements, said ring elements in said second group having a cross-sectional size which is greater than a cross-sectional size of said ring elements in said first group.

14. The packaging cushion as claimed in claim 1,  
5 wherein said ring elements are formed from a resilient material.

15. The packaging cushion as claimed in claim 14, wherein said ring elements include a hollow chamber at least partially filled with a filler medium.

16. The packaging cushion as claimed in claim 15,  
10 wherein said filler medium comprises air.

17. The packaging cushion as claimed in claim 15, further comprising a valve member defining an opening for supplying said filler medium to an interior of said chamber.

18. A packaging cushion for holding at least one  
15 object, comprising

one or more ring elements extending generally in a horizontal plane and having top and bottom surfaces, said ring elements defining one or more openings; and

at least one web of material positioned in said  
20 one or more openings and dividing said one or more openings into an upper pocket and a lower pocket.

19. The packaging cushion as claimed in claim 18, further comprising a plurality of upper nodes projecting upwardly from said ring elements at spaced-apart locations, said upper  
25 nodes having top surfaces disposed higher than said top surfaces of said ring elements.

20. The packaging cushion as claimed in claim 19, further comprising a plurality of lower nodes projecting downwardly from said ring elements at spaced-apart locations, said lower nodes having bottom surfaces disposed lower than said  
30 bottom surfaces of said ring elements.

21. The packaging cushion as claimed in claim 20, wherein each one of said upper nodes is substantially aligned over one of said lower nodes to define a plurality of node pairs.

22. The packaging cushion as claimed in claim 21, wherein, for each one of said node pairs, said top surface of said upper node is spaced from said bottom surface of said lower node by a separation distance, said separation distance for each  
5 one of said node pairs being about the same.

23. The packaging cushion as claimed in claim 18, wherein said ring elements are formed from a resilient material.

24. The packaging cushion as claimed in claim 23, wherein said ring elements include a hollow chamber at least  
10 partially filled with a filler medium.

25. A packaging cushion for holding at least one object, comprising

one or more ring elements extending generally in a horizontal plane, and having top and bottom surfaces, said ring  
15 elements defining one or more compartments; and

means in said one or more compartments for supporting the object in a suspended position in which the object is higher than said lower surfaces of said ring elements.

26. A packaging assembly, comprising  
20 a cushion having one or more ring elements extending generally in a horizontal plane, said ring elements defining one or more openings, said ring elements having top and bottom surfaces and having interior side surfaces facing toward said one or more openings;

25 at least one tray having a bottom, outwardly-sloping sidewalls and a top edge, said at least one tray being assembled in one of said openings with said interior side surfaces of said ring elements engaging said sidewalls of said tray to support said tray in a suspended position.

30 27. The packaging assembly as claimed in claim 26, further comprising a plurality of upper nodes projecting upwardly from said ring elements at spaced-apart locations, said upper nodes having top surfaces disposed higher than said top surfaces of said ring elements, said top edge of said tray in said

suspended position being higher than said top surfaces of said ring elements and lower than said top surfaces of said upper nodes.

28. The packaging assembly as claimed in claim 27,  
5 wherein said top surfaces of said upper nodes are at substantially the same height.

29. The packaging assembly as claimed in claim 27,  
further comprising a plurality of lower nodes projecting  
downwardly from said ring elements at spaced-apart locations,  
10 said lower nodes having bottom surfaces disposed lower than said  
bottom surfaces of said ring elements, said at least one tray  
being assembled in said one of said openings with said ring  
elements engaging said sidewalls of said tray so that said bottom  
of said tray lies lower than said bottom surfaces of said ring  
15 elements and higher than said bottom surfaces of said lower  
nodes.

30. The packaging assembly as claimed in claim 29,  
wherein said bottom surfaces of said lower nodes are at  
substantially the same height.

20 31. The packaging assembly as claimed in claim 29,  
wherein each one of said upper nodes is substantially aligned  
over one of said lower nodes to define a plurality of node pairs.

32. The packaging assembly as claimed in claim 31,  
wherein, for each one of said node pairs, said top surface of  
25 said upper node is spaced from said bottom surface of said lower  
node by a separation distance, said separation distance for each  
one of said node pairs being about the same.

33. The packaging structure as claimed in claim 26,  
wherein said interior side surfaces of said ring elements have a  
30 substantially cylindrical contour.

34. The packaging structure as claimed in claim 26,  
wherein said ring elements have a cross-sectional size, said  
cross-sectional size of each one of said ring elements being  
about the same.

35. The packaging assembly as claimed in claim 26, wherein said ring elements have a cross-sectional size, said cross-sectional size of a first group of said ring elements being substantially less than said cross-sectional size of a second group of said ring elements.

36. The packaging assembly as claimed in claim 35, wherein said first group of ring elements are disposed between adjacent ones of said openings.

37. The packaging assembly as claimed in claim 36, further comprising a plurality of trays, each tray having a bottom, outwardly-sloping sidewalls, a top edge and a flange projecting outwardly from said top edge, said plurality of trays being assembled in said openings so that said flange of one of said trays overlaps with said flange of an adjacent one of said trays.

38. The packaging assembly as claimed in claim 26, wherein said ring elements define one or more rows of said openings, said openings in each of said rows being separated by a first group of said ring elements.

39. The packaging assembly as claimed in claim 38, wherein said ring elements define two or more rows of said openings, said openings in one of said rows being separated from said openings in another one of said rows by a second group of said ring elements, said ring elements in said second group having a cross-sectional size which is greater than a cross-sectional size of said ring elements in said first group.

40. The packaging assembly as claimed in claim 26, wherein said ring elements are formed from a resilient material.

41. The packaging assembly as claimed in claim 40, wherein said ring elements include a hollow chamber at least partially filled with a filler medium.

42. The packaging assembly as claimed in claim 41, wherein said filler medium comprises air.



43. The packaging assembly as claimed in claim 41, further comprising a valve member defining an opening for supplying said filler medium to an interior of said chamber.

44. A packaging assembly for holding at least one  
5 article, comprising

a cushion having one or more ring elements extending generally in a horizontal plane and having top and bottom surfaces, said ring elements defining one or more openings;

10 at least one web of material positioned in said one or more openings and dividing said one or more openings into an upper pocket and a lower pocket; and

at least one object assembled in said upper pocket so that said at least one object is supported at a position  
15 higher than said bottom surfaces of said ring elements.

45. The packaging assembly as claimed in claim 44, further comprising at least one slit dividing said at least one web of material into a first portion and a second portion, and wherein said at least one object is supported in said upper  
20 pocket between said first and second portions of said at least one web of material.

46. The packaging assembly, as claimed in claim 44, further comprising a plurality of apertures formed in said at least one web of material.

25 47. The packaging assembly as claimed in claim 44, further comprising a plurality of slits formed in said at least one web of material.

48. A shipping package, comprising  
a plurality of cushions, each cushion having upper  
30 and lower surfaces and one or more compartments;

at least one object assembled in said one or more compartments so that said object is supported at a position higher than said lower surface of said cushion in which it is assembled;

said cushions being arranged one on top of another to form a stack; and

an outer container assembled around said stack for holding said stack in assembled relationship.

5           49. The shipping package as claimed in claim 48, wherein said compartments in each one of said cushions in said stack confront corresponding ones of said compartments in an adjacent one of said cushions to define packaging cells, whereby said at least one object is assembled in said packaging cells.

10           50. The shipping package as claimed in claim 48, wherein said outer container comprises a securing material wrapped around said stack.

          51. The shipping package as claimed in claim 50, further comprising at least one handle connected to said securing  
15 material.

          52. The shipping package as claimed in claim 50, wherein said stack has a top end, a bottom end and a plurality of sides, said securing material including a film material wrapped around said plurality of sides of said stack.

20           53. The shipping package as claimed in claim 52, wherein said film material is wrapped around said top and bottom ends of said stack.

          54. The shipping package as claimed in claim 52, wherein said film material comprises a polymer.

25           55. The shipping package as claimed in claim 48, wherein said outer container comprises a box.

          56. The shipping package as claimed in claim 48, further comprising a plurality of upper nodes projecting upwardly from said upper surfaces of said cushions at spaced-apart  
30 locations, said upper nodes having top surfaces disposed higher than said upper surfaces of said cushions.

          57. The shipping package as claimed in claim 56, wherein said upper nodes in each one of said cushions in said

stack are substantially aligned with corresponding ones of said upper nodes in an adjacent one of said cushions.

58. The shipping package as claimed in claim 56, wherein said outer container comprises a securing material  
5 wrapped around said stack.

59. The shipping package as claimed in claim 58, further comprising a stabilizing layer positioned between an uppermost one of said cushions in said stack and said securing material.

10 60. The shipping package as claimed in claim 56, further comprising a plurality of lower nodes projecting downwardly from said lower surfaces of said cushions at spaced apart locations, said lower nodes having bottom surfaces disposed lower than said lower surfaces of said cushions.

15 61. The shipping package as claimed in claim 60, wherein said outer container comprises a securing material wrapped around said stack, said shipping package further comprising a stabilizing layer positioned between a lowermost one of said cushions in said stack and said securing material.

20 62. The shipping package as claimed in claim 60, wherein, for each one of said cushions, said upper nodes are substantially aligned over corresponding ones of said lower nodes to define a plurality of node pairs.

25 63. The shipping package as claimed in claim 62, wherein said node pairs in each one of said cushions are substantially aligned with corresponding ones of said node pairs in an adjacent one of said cushions.

64. The shipping package as claimed in claim 48, wherein said cushions are formed from a resilient material.

30 65. The shipping package as claimed in claim 64, wherein said cushions include a hollow chamber at least partially filled with a filler medium.

66. The shipping package as claimed in claim 65, wherein said filler medium comprises air.

67. The shipping package as claimed in claim 65, further comprising a valve member defining an opening for supplying said filler medium to an interior of said chamber.

68. A shipping package, comprising  
5 a plurality of cushions, each cushion including one or more ring elements extending generally in a horizontal plane and having top and bottom surfaces, said ring elements defining one or more compartments;

at least one object assembled in said one or more  
10 compartments so that said object is supported at a position higher than said bottom surfaces of said ring elements;

said cushions being arranged one on top of another to form a stack; and

an outer container assembled around said stack for  
15 holding said stack in assembled relationship.

69. The shipping package as claimed in claim 68, wherein said one or more compartments in each one of said cushions confront corresponding ones of said compartments in an adjacent one of said cushions to define packaging cells, whereby  
20 said at least one object is assembled in said packaging cells.

70. The shipping package as claimed in claim 68, further comprising first and second webs of material positioned in said one or more compartments and dividing said one or more compartments into an upper pocket and a lower pocket, said first  
25 web of material confronting said second web of material to define a space therebetween, one of said first and second webs of material including a slit providing access to said space, said at least one object being assembled in said space.

71. The shipping package as claimed in claim 68,  
30 further comprising at least one web of material positioned in said one or more compartments and dividing said one or more compartments into an upper pocket and a lower pocket, wherein said at least one object is supported in said upper pocket on said web of material.

72. The shipping package as claimed in claim 71, further comprising at least one slit dividing said at least one web of material into a first portion and a second portion, and wherein said at least one object is supported in said upper  
5 pocket between said first and second portions of said at least one web of material.

73. The shipping package as claimed in claim 71, further comprising a plurality of apertures formed in said at least one web of material.

10 74. The shipping package as claimed in claim 71, further comprising a plurality of slits formed in said at least one web of material.

75. A method of packaging at least one tray having a bottom, outwardly-sloping sidewalls and a top edge, said method  
15 comprising

providing a cushion having one or more ring elements extending generally in a horizontal plane, said ring elements defining one or more openings, said ring elements having top and bottom surfaces and having interior side surfaces facing  
20 toward said one or more openings; and

positioning said at least one tray in one of said openings to form an assembly in which said interior side surfaces of said ring elements engage said sidewalls of said tray to support said tray in a suspended position.

25 76. The packaging method as claimed in claim 75, wherein said step of providing said cushion includes the step of providing said cushion with a plurality of upper nodes projecting upwardly from said ring elements at spaced-apart locations, said upper nodes having top surfaces disposed higher than said top  
30 surfaces of said ring elements, and wherein said positioning step includes the step of positioning said tray so that said top edge of said tray in said suspended position lies higher than said top surfaces of said ring elements and lower than said top surfaces of said upper nodes.

77. The packaging method as claimed in claim 76, wherein said step of providing said cushion includes the step of providing said cushion with a plurality of lower nodes projecting downwardly from said ring elements at spaced-apart locations, 5 said lower nodes having bottom surfaces disposed lower than said bottom surfaces of said ring elements, and wherein said positioning step includes the step of positioning said tray so that said bottom of said tray in said suspended position lies lower than said bottom surfaces of said ring elements and higher 10 than said bottom surfaces of said lower nodes.

78. The packaging method as claimed in claim 75, wherein said ring elements are formed from a resilient material.

79. The packaging method as claimed in claim 78, wherein said ring elements include a hollow chamber.

80. The packaging method as claimed in claim 79, further comprising the step of at least partially filling said hollow chamber with a filler medium.

81. The packaging method as claimed in claim 75, further comprising the step of at least partially surrounding 20 said assembly with an outer container to hold said at least one tray and said cushion in assembled relationship.

82. The packaging method as claimed in claim 81, wherein said surrounding step includes the step of wrapping a film material around said assembly.

83. The packaging method as claimed in claim 82, further comprising the step of connecting at least one handle to 25 said film material.

84. A method of packaging objects, comprising providing a plurality of cushions, each cushion 30 having upper and lower surfaces and one or more compartments; assembling said objects in said compartments so that said objects are supported at positions higher than said lower surfaces of said cushion in which they are assembled;

arranging said plurality of cushions one on top of another to form a stack; and

at least partially surrounding said stack with an outer container to hold said stack in assembled relationship.

5           85. The packaging method as claimed in claim 84, wherein said step of providing said cushions includes the step of providing said cushions with a plurality of upper nodes projecting upwardly from said upper surfaces of said cushions at spaced-apart locations, said upper nodes having top surfaces  
10 disposed higher than said upper surfaces of said cushions.

86. The packaging method as claimed in claim 85, wherein said arranging step includes the step of arranging said cushions so that said upper nodes in each one of said cushions are substantially aligned with corresponding ones of said upper  
15 nodes in an adjacent one of said cushions.

87. The packaging method as claimed in claim 85, wherein said step of providing said cushions includes the step of providing said cushions with a plurality of lower nodes projecting downwardly from said lower surfaces of said cushions  
20 at spaced-apart locations, said lower nodes having bottom surfaces disposed lower than said lower surfaces of said cushions.

88. The packaging method as claimed in claim 87, wherein, for each one of said cushions, said upper nodes are  
25 substantially aligned over corresponding ones of said lower nodes to define a plurality of node pairs.

89. The packaging method as claimed in claim 88, wherein said node pairs in each one of said cushions are substantially aligned with corresponding ones of said node pairs  
30 in an adjacent one of said cushions.

90. The packaging method as claimed in claim 84, wherein said arranging step includes the step of arranging said cushions so that said compartments in each one of said cushions confront corresponding ones of said compartments in an adjacent

one of said cushions to define packaging cells, said objects being assembled in said packaging cells.

91. The packaging method as claimed in claim 84, wherein said cushions are formed from a resilient material.

5 92. The packaging method as claimed in claim 91, wherein each of said cushions includes a hollow chamber.

93. The packaging method as claimed in claim 92, further comprising the step of at least partially filling said hollow chambers with a filler medium.

10 94. The packaging method as claimed in claim 84, wherein said surrounding step includes the step of wrapping a film material around said stack.

95. The packaging method as claimed in claim 94, wherein said surrounding step further includes the step of  
15 positioning a stabilizing layer between an uppermost one of said cushions in said stack and said film material.

96. The packaging method as claimed in claim 95, wherein said surrounding step further includes the step of  
20 positioning a stabilizing layer between a lowermost one of said cushions in said stack and said film material.

97. The packaging method as claimed in claim 94, wherein said stack has a top end, a bottom end and a plurality of sides, said surrounding step including the step of wrapping said film material around said plurality of sides of said stack.

25 98. The packaging method as claimed in claim 97, wherein said surrounding step further includes the step of wrapping said film material around said top and bottom ends of said stack.

99. The packaging method as claimed in claim 94,  
30 wherein said film material comprises a polymer.

100. The packaging method as claimed in claim 94, further comprising the step of connecting at least one handle to said film material.



1/8

FIG. 1

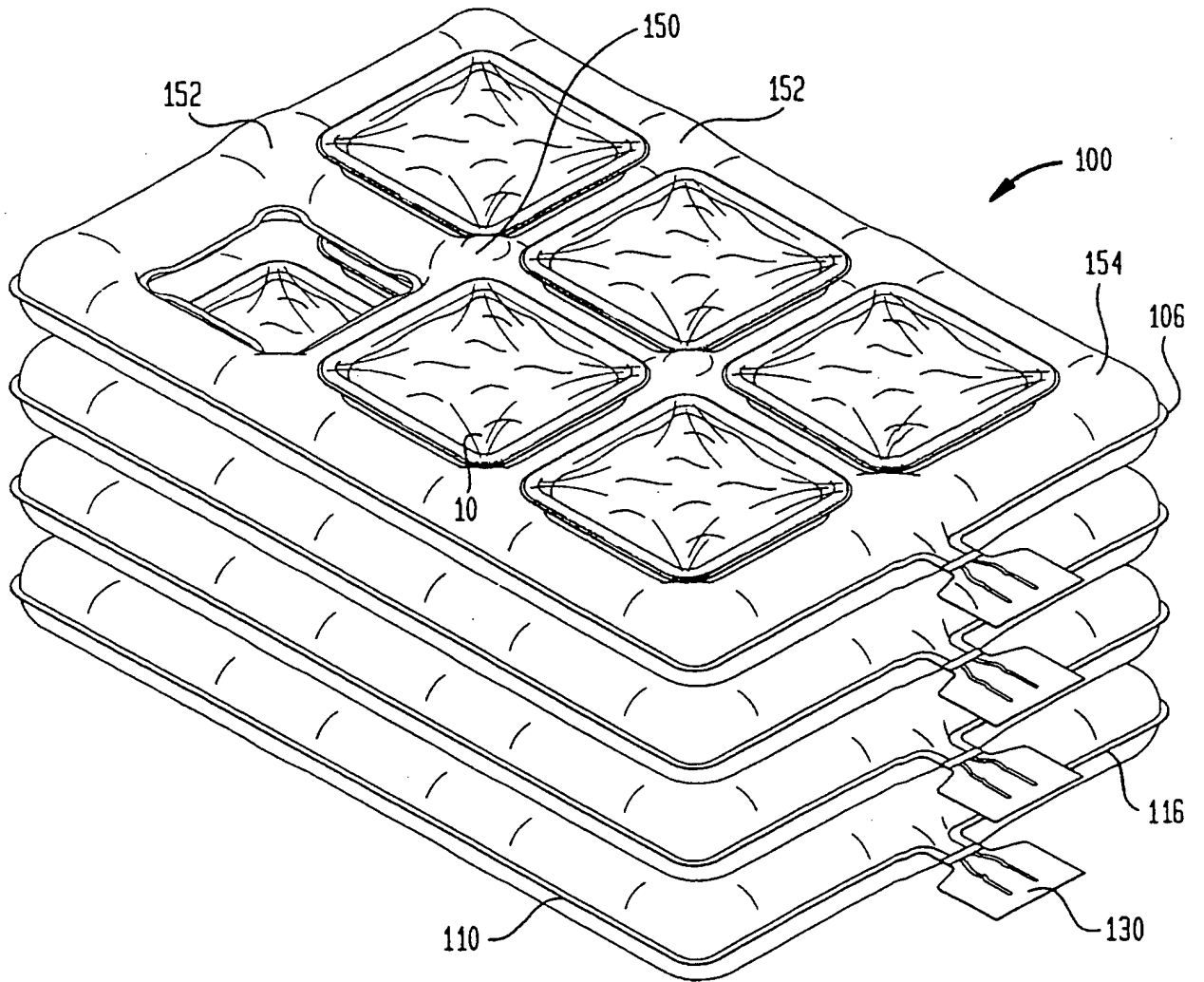


FIG. 2

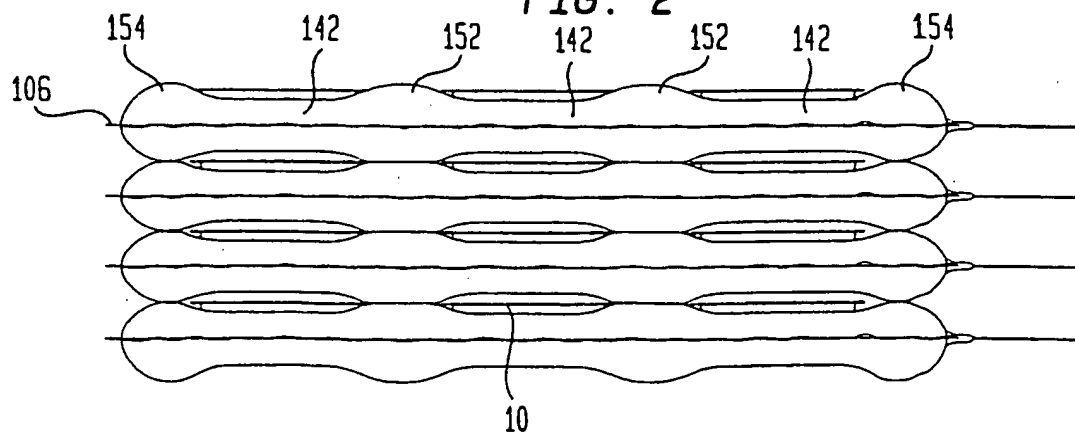


FIG. 3

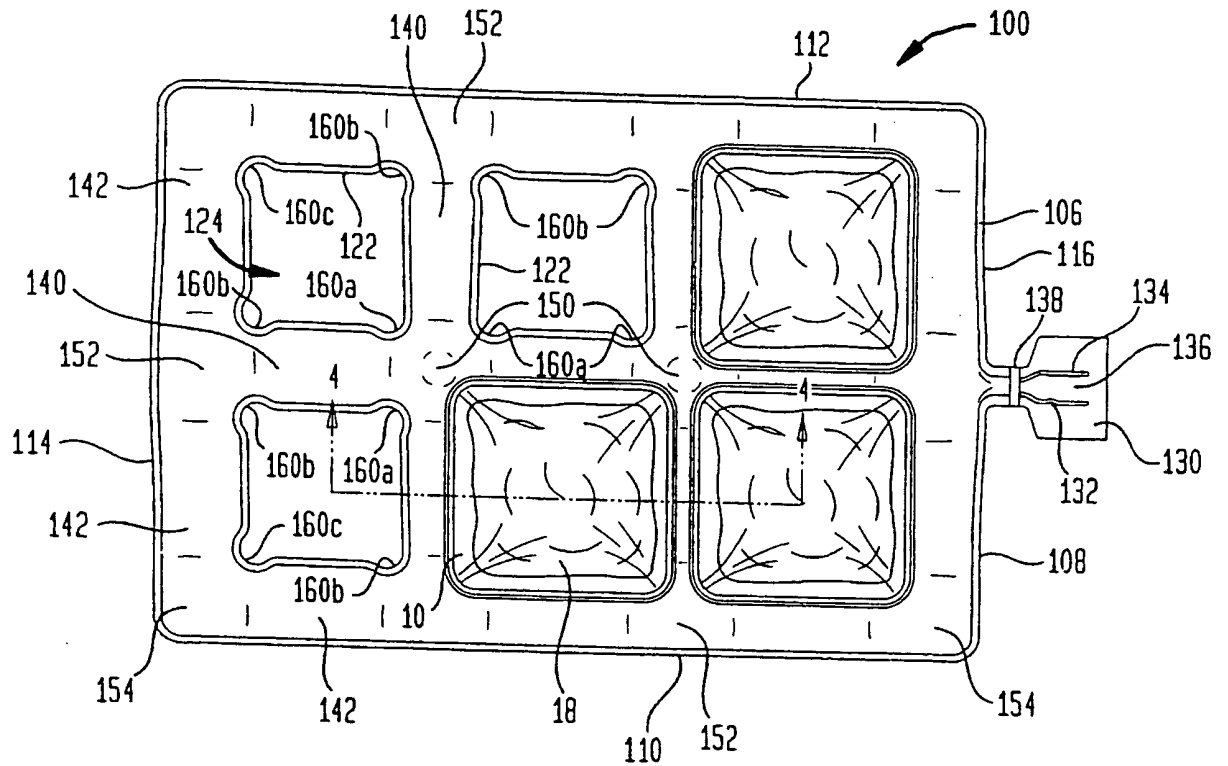
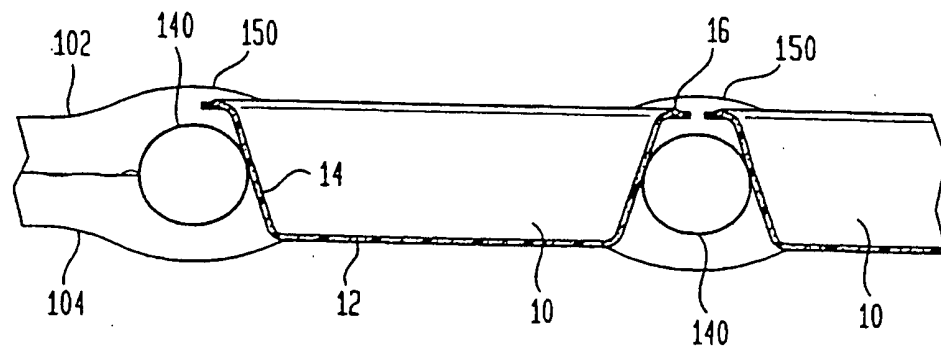


FIG. 4



3/8

FIG. 5

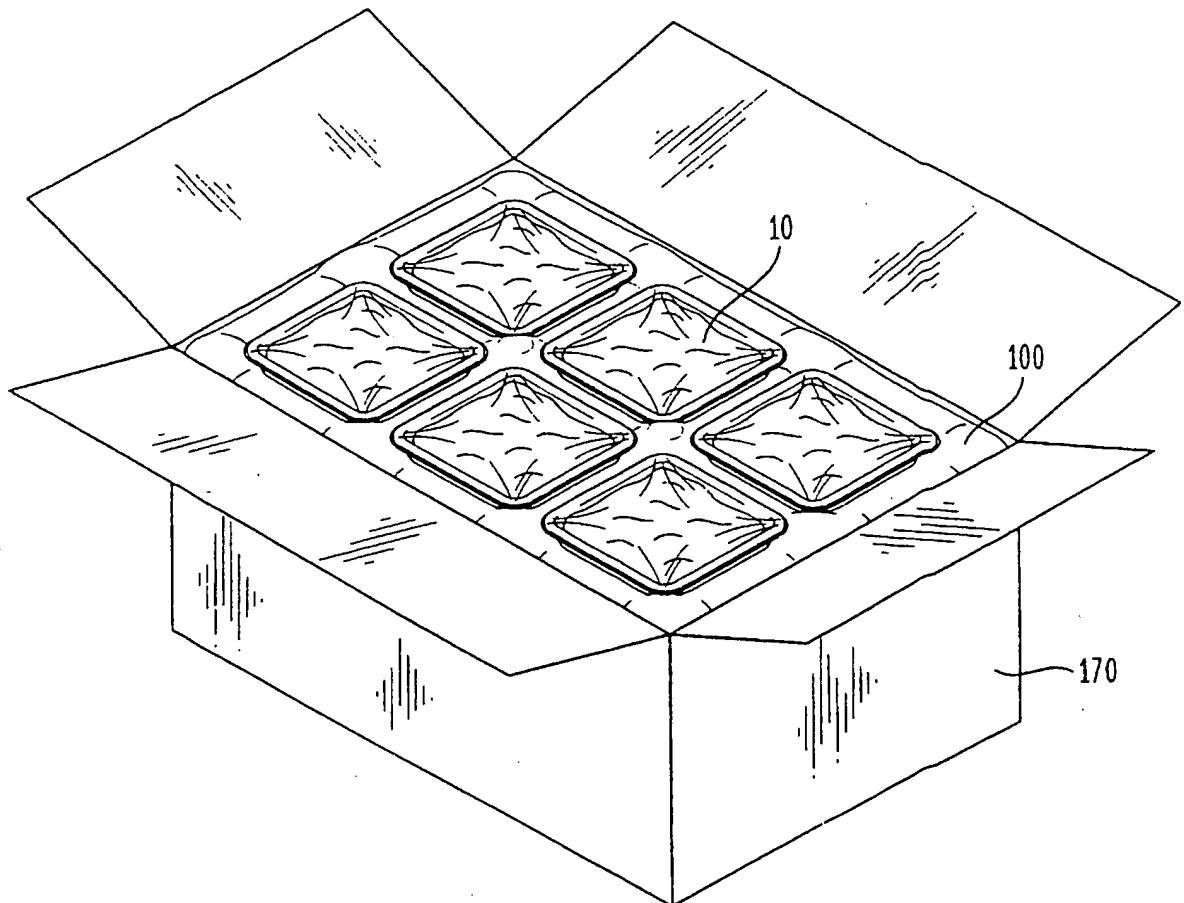
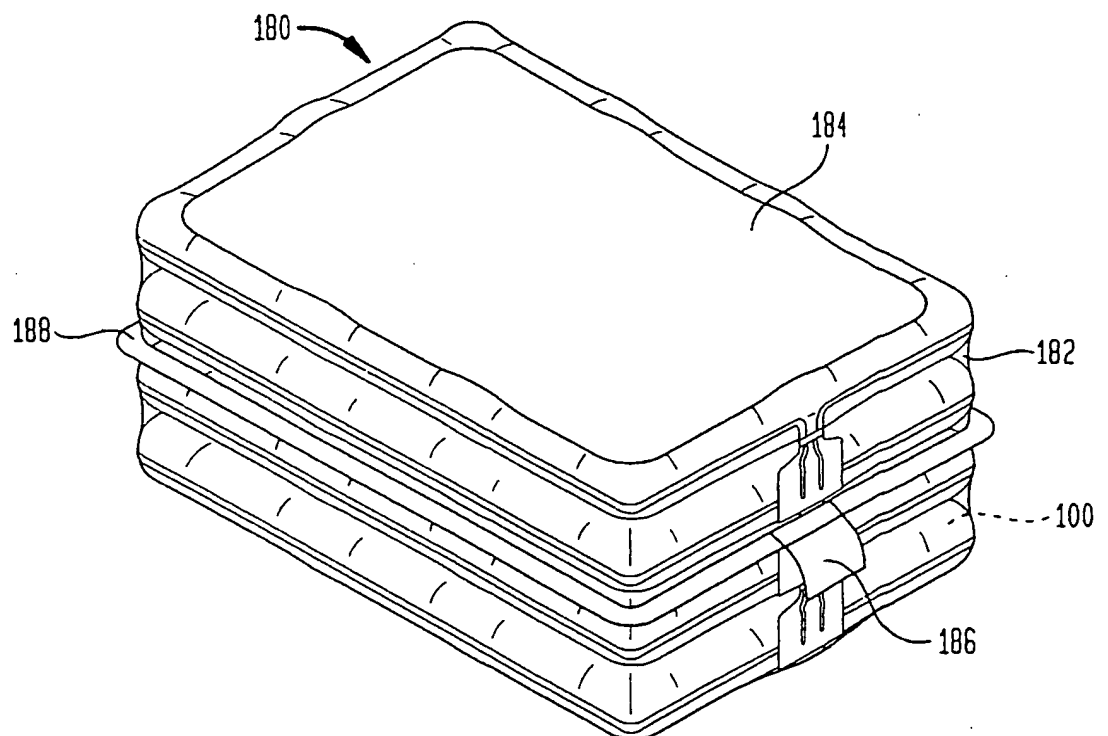
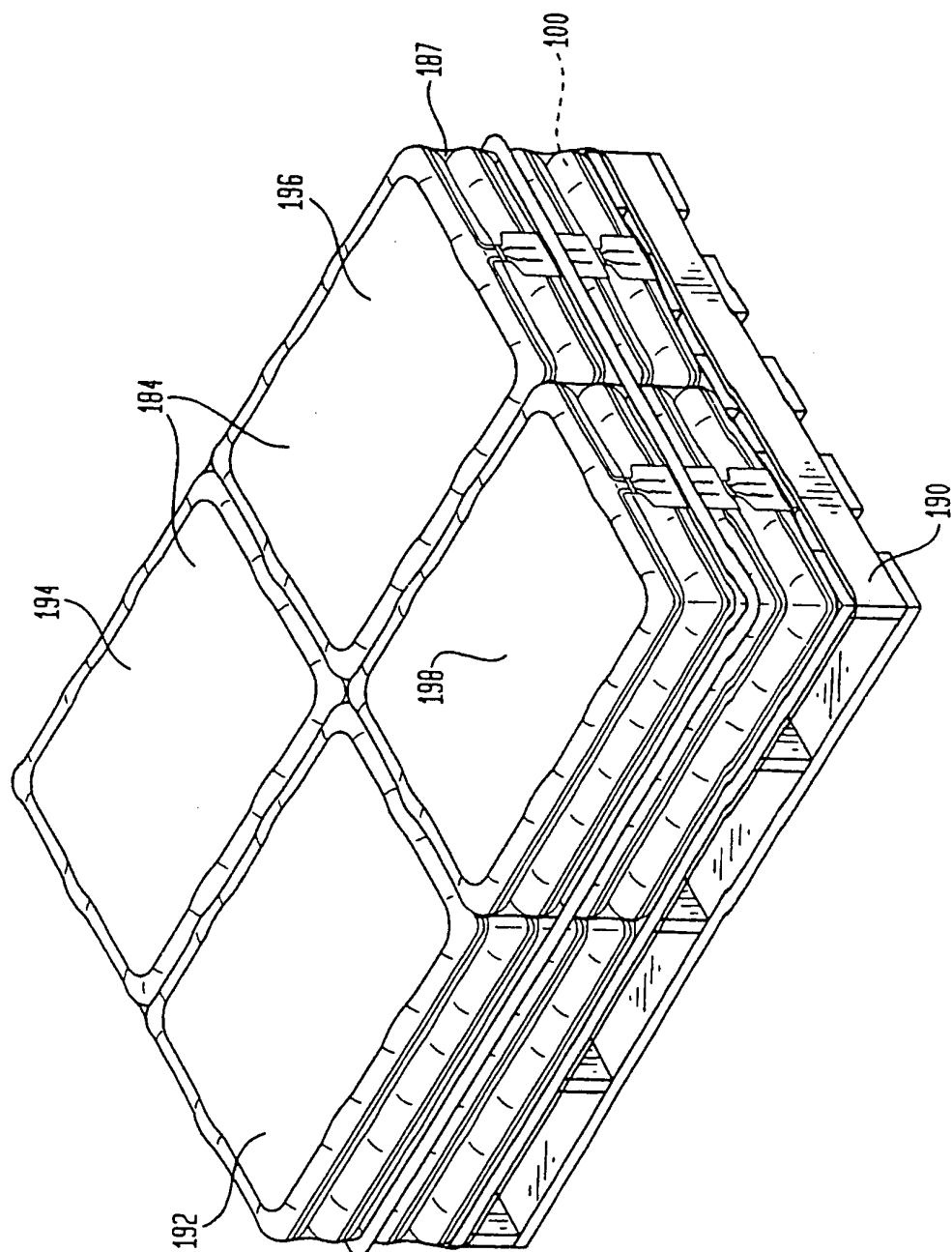


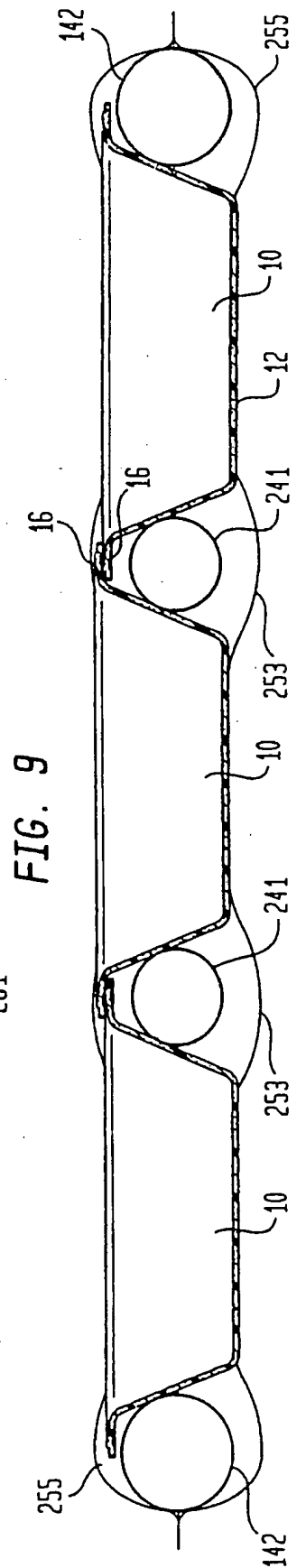
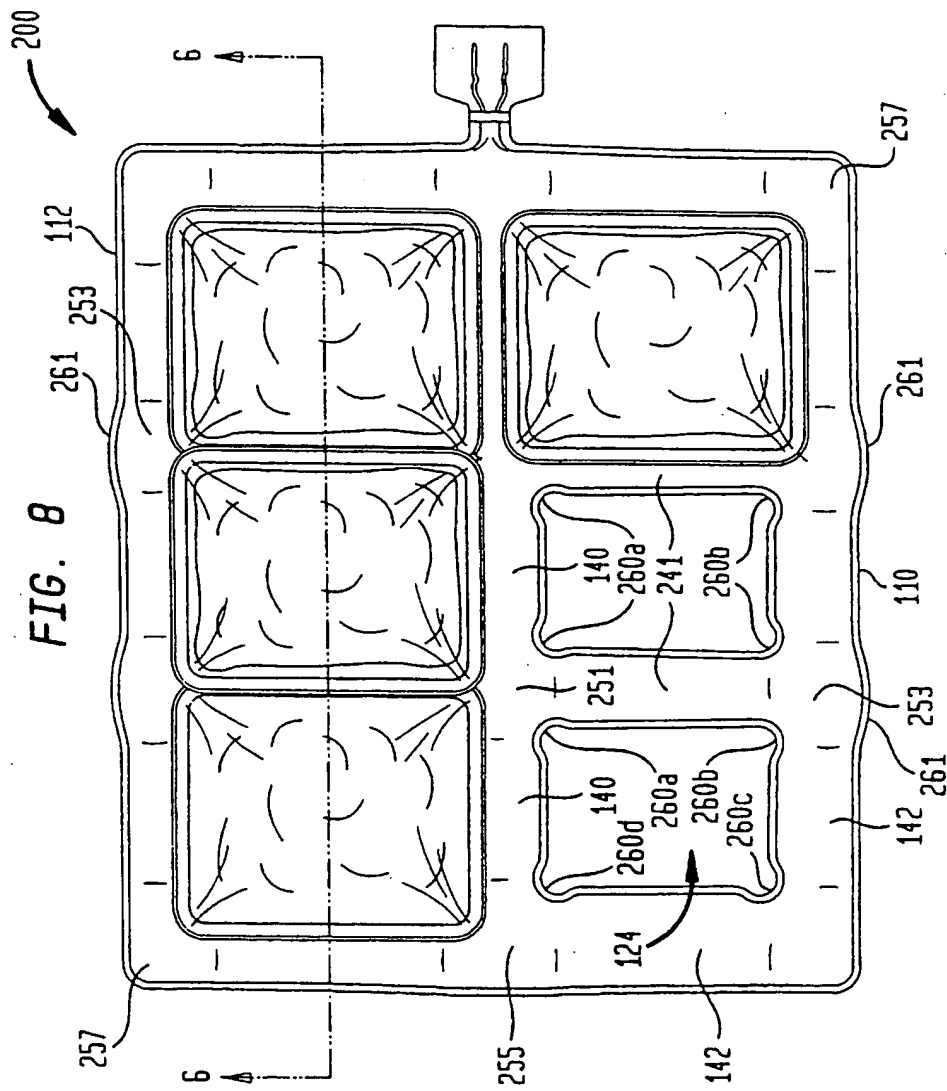
FIG. 6



4/8

FIG. 7





6/8

FIG. 10

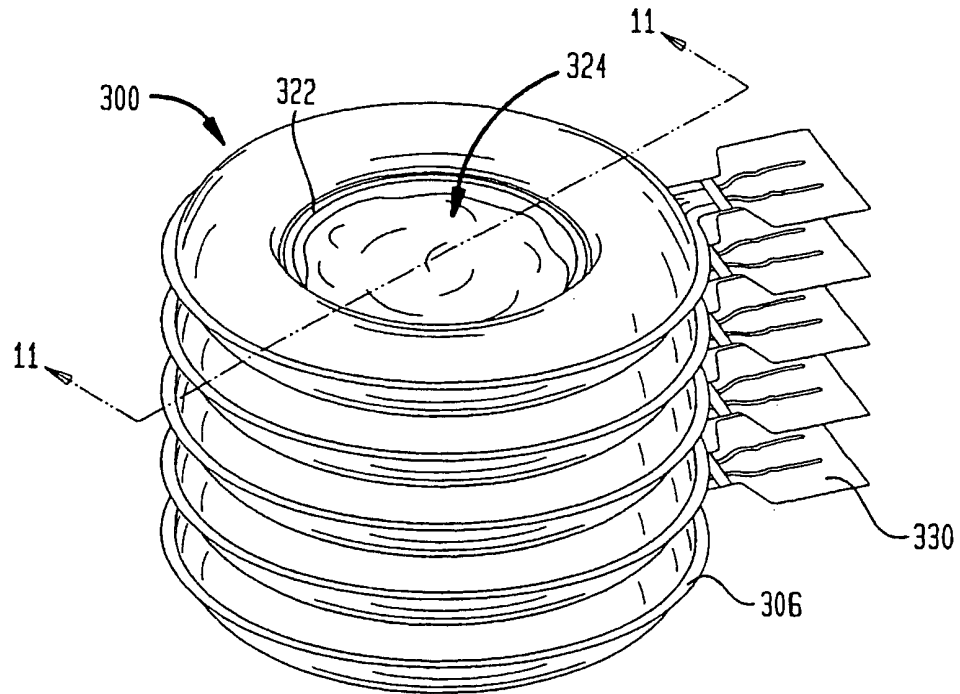
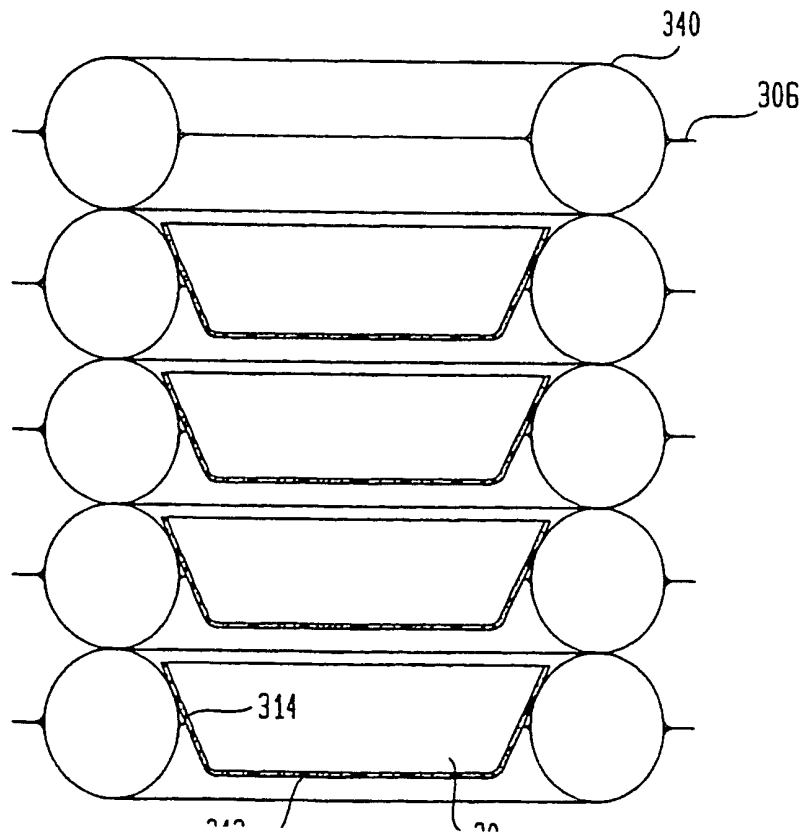


FIG. 11



7/8

FIG. 12

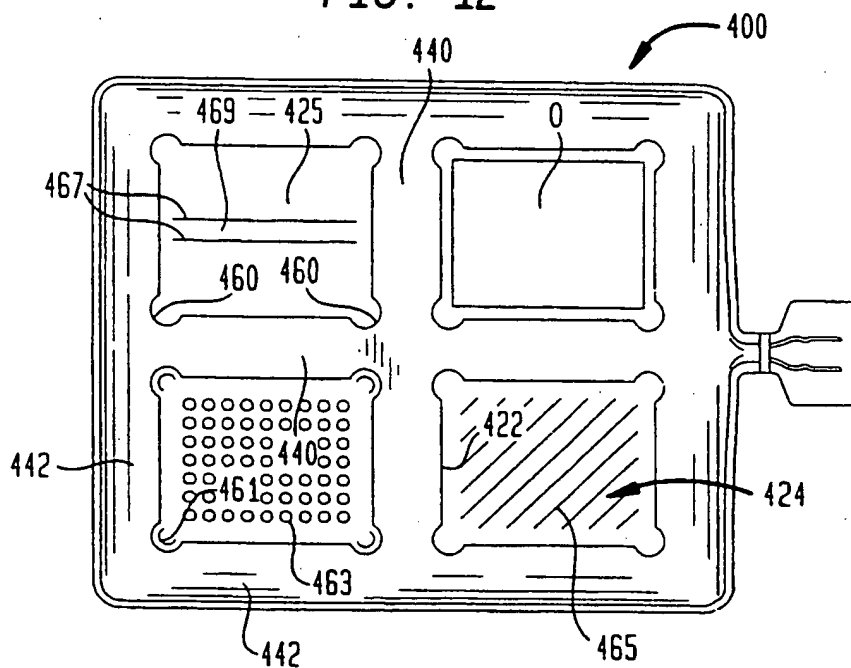
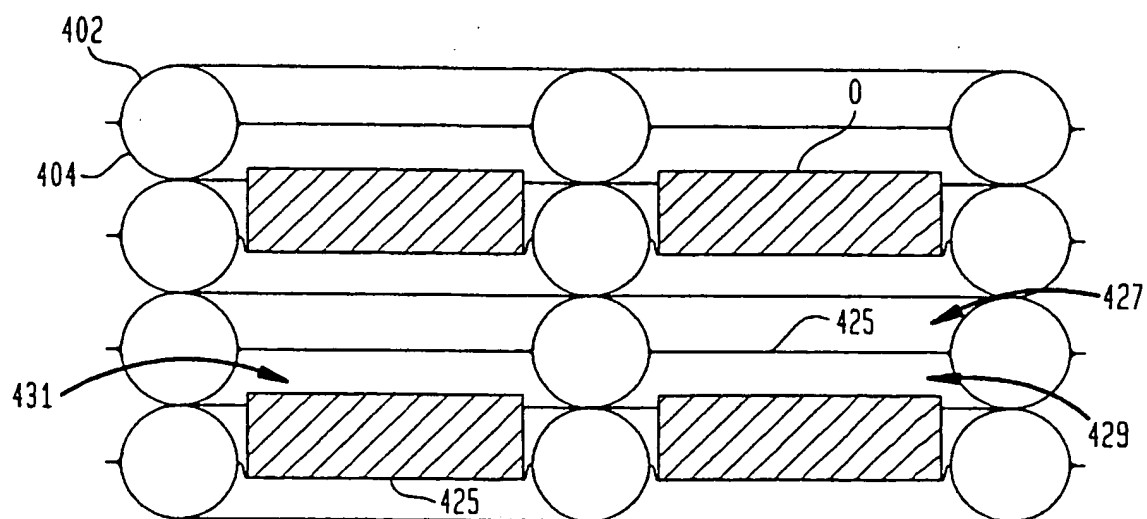
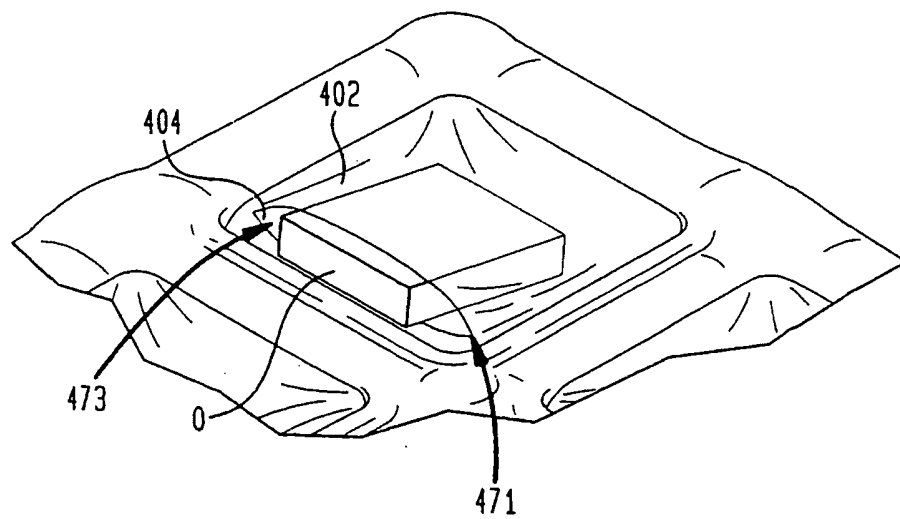


FIG. 13



8/8

FIG. 14





# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US00/30510

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B65D 81/05

US CL : 206/499, 522

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 206/150, 497, 499, 521-523, 562, 563, 588-590

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 1,499,369 A (HOLLAND) 01 July 1924, see Figure 2 and column 1, line 22 through column 2, line 67.	1, 8, 9, 12, 25, 84
X	US 3,226,285 A (IOVENKO) 28 December 1965, see Figure 1 and column 3, lines 1-10.	1-7, 9, 12, 14-16, 25
X	US 3,366,231 A (TRAKAS) 30 January 1968, see Figures 1-4 and column 1, line 44 through column 3, line 28.	18-24, 44, 48-50, 52, 58, 60-69, 71, 84-93
X	US 3,398,501 A (ANINGER) 27 August 1968, see Figure 1 and column 1, line 59 through column 2, line 21.	1-12, 14-17, 25



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

27 DECEMBER 2000

Date of mailing of the international search report

22 JAN 2001

Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Authorized officer

JIMMY G. FOSTER

*Sheila Venzky*  
Paralegal Specialist

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US00/30510

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 3,451,536 A (O'LEARY et al) 24 June 1969, see Figures 1-3 and column 2, line 9 through column 3, line 15.	1, 8-11, 13-16, 25, 26, 33-36, 38-42, 48-50, 52- 55, 58, 64, 65, 75, 78-82, 84, 93, 94, 97-99 ----- 51, 83, 100
X	US 5,154,289 A (VAN ERDEN) 13 October 1992, see Figure 4 and column 3, lines 60-68.	1, 9-14, 25
X	US 5,634,555 A (DUNHAM) 03 June 1997, see Figures 2-4 and column 3, line 30 through column 4, line 30.	48, 56-58, 84-86
Y	US 4,779,731 A (FUJIO) 25 October 1988, see Figure 8 and column 4, line 52 through column 5, line 39.	51, 83 100

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☒ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☒ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**

**THIS PAGE BLANK (USPTO)**